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THE GOLD FIELDS OF THE TRANSVAAL.

It is a noteworthy coincidence that the two international complications which for a while threatened to plunge both hemispheres into war may both be said to have had their origin in the greed of the gold seeker. It was the newly discovered gold fields of Barima that drew the Guiana colonist to the westward and that rendered the British boundary line so proportionately elastic that it suddenly encircled a territory just twice the area of the original disputed lands!

If the gold fields of the Rand had not yielded up their secret, we should never have heard of Johannesburg or Krugersdorp, the oppression of the Boers or the wrongs of the Uitlander.

Up to the year 1886, when gold was first discovered in the Transvaal, there was nothing in the country specially to distinguish it from the rest of the rolling grass lands of the great South African plateau. The Boer farms, like the ranges of western America, were

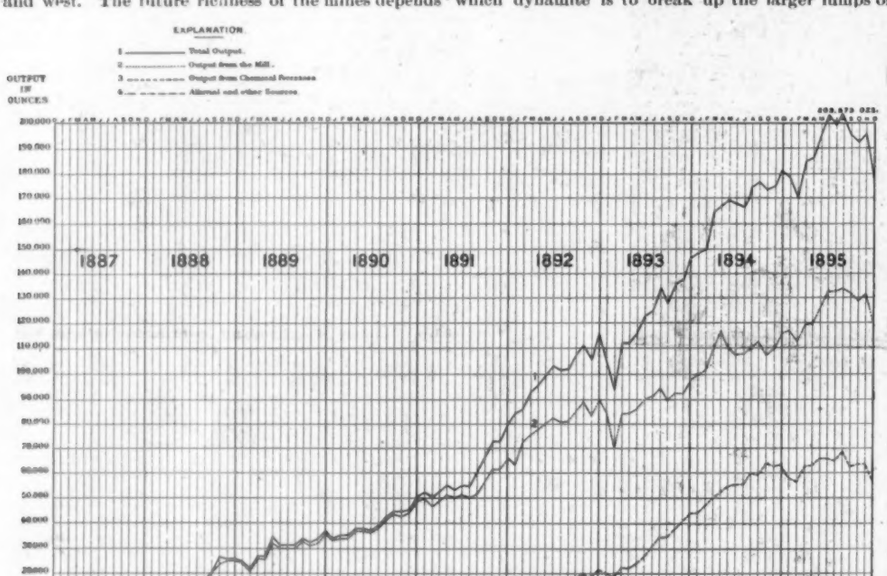
MINING AT JOHANNESBURG—NATIVES ON THE WAY TO THEIR WORK.

given up to the raising of stock; and what time the farmers were not busy with the cares of the farm they were out with the rifle in search of game for the home larder. For your average Boer is a mighty huntsman; and with true Dutch economy he was careful of his ammunition—for it was scarce and costly in those days. He shot to kill, and in this way he acquired that splendid marksmanship which has won him so many a battle.

Following upon the discovery of gold came the inevitable "rush" of adventurers. The new fields were found to be of unusual richness and extent, and the output increased rapidly. We present a diagram, for which we are indebted to the Johannesburg Standard and Diggers' News, showing the output from the Rand District from 1887, when it amounted to 35,000 ounces, or $630,000, to 1895, when it reached 2,277,635 ounces, worth about $41,000,000. The above journal, commenting on the decrease which, it will be noticed from the diagram, has occurred since last August, says: "From August, when the record of 203 573 ounces was reached, down to the present, the output, month after month, has been very disappointing, and circumstances do not appear to favor an immediate improvement."

The decrease is to be attributed in part to the scarcity of native labor, and partly to the late political disturbances. The same journal goes on to say: "The Rand is scarcely more than in its infancy, and it is estimated that before the close of the present century the record output of August last will be more than doubled."

Gold was first discovered near the site of the present town of Johannesburg on the southern slope of a range of hills called the Witwatersrand. It is found in the outcropping of the conglomerate beds, which extend from the Witwatersrand to probably some distance south of the Vaal River. The central and northern portions are the richest. They cover a stretch of country that reaches many miles east and west. The future richness of the mines depends upon the depth to which the conglomerate beds penetrate. The recent Geldenhuis deep crushing—the first deep level output—was unsatisfactory, but the deeper levels must be more fully tested before it can be asserted that the conglomerate beds are comparatively shallow.



GOLD OUTPUT FROM THE TRANSVAAL MINES FROM 1887 TO 1895.

The history of the mining methods adopted for the recovery of the gold has been the same in South Africa as in America or Australia. First came the prospector with his pan. His operations were confined to the alluvial deposits, usually the richest of all gold-bearing material. Such gold as he could not save in his pan in the form of nuggets and "dust" he was content to lose. Then came the importation of machinery, with the mining and crushing of the quartz. It was at this stage that the future of the newly discovered fields looked doubtful; for it was found that the ore was extremely rebellious or refractory, and was not amenable to amalgamation on the battery plates.

It should be explained here that in the process of recovery of the gold in the stamp batteries, the ore is first crushed under falling "stamps" or hammers to great fineness, with a view to liberating the finely divided particles of gold from the inclosing quartz; and this finely crushed material is mixed with water and allowed to run in a thin stream over inclined silver plated copper plates, upon which a thin layer of mercury has been spread. The liberated particles of gold come in contact with the mercury as the crushed material flows over the plates and is amalgamated, the amalgam adhering to the plate. This amalgam is scraped off and placed in retorts, where the mercury is volatilized and passes off, leaving the gold behind.

In many mines, however, the gold is found to be so chemically or otherwise affected that it refuses to amalgamate on the battery plates, and passes away with the sand and quartz into what are known as the "tailings," or refuse heaps. The gold of the Rand was largely of this nature, and the loss was so large as to render the profits very uncertain. The difficulty was solved however by the introduction of a "leaching" or solution process, which had already been tried with great success in America and Australia. In this process the tailings are gathered in large settling vats, and then treated with cyanide of potassium. The cyanide dissolves out the gold, which is subsequently precipitated, and recovered.

We present our readers with a very graphic illustration of the entrance to the New Primrose mine, one of the largest working gold mines in the world. It is reproduced from one of a series which are being published by the Illustrated News, from sketches by their special correspondent at Johannesburg. The monthly output from this mine alone is valued at 216,000 dollars; and according to this correspondent the various mines of which the New Primrose is one stretch in one line for over forty miles. The labor in these mines is chiefly performed by the natives; and to save the time which would be consumed in transferring them to and from work by the trolley, the wooden steps shown in the engraving are provided. The particular "stope" in which the mining is now being carried on in the New Primrose is about 550 feet long by 120 feet from the ninth level to the eighth, and about 50 feet high from the foot wall to the hanging wall. Says the same correspondent: "It was a wonderful sight. In all directions natives in the scantiest of clothing were working away at drills, each man having a candle. The whole scene presented quite a fairy-like appearance. All the material that is broken down or stoped out from this place is sent to the surface in much the same manner as in coal mines, and then forwarded on to the stamping mill. The method of working here is as follows: Compressed air drills are used to bore holes into the side of the stope, some sixteen or eighteen or even twenty inches deep, and when finished they are filled with dynamite, which is fired at 5:30 both morning and evening, just after the shift of men has quitted work. When the men of the next shift come on they find large blocks of reef have been broken down, weighing from one to twenty tons, and then the Kaffir laborers are put to work clearing up and collecting the fine stuff, and preparing and boring fresh holes, in which dynamite is to break up the larger lumps of reef. The air drills are then again erected, and set to work drilling as before."

We present also a cut of a South African stage-coach, which is drawn by a team the like of which could not be found outside of that country, unless it were in some itinerant circus of the larger kind. As will be seen, it is composed of mules and zebras, the latter being a native of the South African country. The zebra is rather smaller than the wild horse; it is very hardy, and is possessed of great speed. In color it is whitish or pale brown, elegantly striped with black bands.

One other illustration, for which we are indebted to Black and White, is reproduced from the latest portrait of President Kruger, which was taken at the door of his own house. It is said that, despite his income of $35,000 a year, the president maintains much of the burgher simplicity in the regulation of his household. The latest European dispatches state that he has accepted an invitation from Mr. Chamberlain, the colonial secretary, to visit London and confer with the British government regarding the Uitlanders of the Rand and the relations of the Transvaal and Great Britain.

[From the American Naturalist.]

THE BIRDS OF NEW GUINEA. (MISCELLANEOUS.)

By G. S. Mead.

In considering the birds of the tropics or of any portion of the tropics, one is apt to suppose that the birds which are seen therein at any time may be seen at all times. In other words, that they are as much fixtures as the trees, that they never migrate. While this may be true of a large number of species, it is not by any means true of every species, even of land birds.

Our own birds are with us a few months only; most of them at the approach of winter go South, where, in tropical lands or in low temperate latitudes, they may be found during a longer period. The mere migrants—those that pause on their way north or south for days only—are not taken into account.

It is well, then, to bear in mind two facts: first, that in every country migratory birds, whose period of stay covers a large proportion of the year, are to be met with besides permanent residents; second, that all birds found by travelers are not necessarily permanent residents, but in many instances transient visitors only.

Birds of paradise are said to move from one island of the Papuan Archipelago to another, in order to avoid storms or stress of weather at certain times of the year. The Nicobar pigeon also, a heavy flier, has been seen many miles distant from the mainland.

Probably, therefore, in New Guinea, although we find a very large resident population, we also discover many birds that have come from Australia or the Asian continent to remain but a partial period. Mr. Jukes illustrates this view in his valuable narrative, "The Voyage of the Fly."

"While we were in this neighborhood (in Torres Straits, Turtleback Island), about the end of February (1845), great flocks of the bee-eater, which is common in Australia (Merops ornatus), were continually passing to the northward. The white pigeons also (Caropophaga luctuosa) were going in the same direction in numerous small flocks, and in March all the pigeons left in the islands were young ones. The bee-eaters go as far to the southward as Sydney during the summer of New South Wales, but we never saw the white pigeons much to the southward of Torres Straits. In September, 1844, they were coming thickly from the northward to Endeavor Strait, and they seem to return in March. What can be the reason of the migration? In these latitudes it is evident that mere temperature cannot be the cause of it, although the variation of the seasons for different fruits or insects may. I had afterward strong reasons for suspecting, that even on the opposite sides of so small a space as Torres Strait, not more than 120 miles, the seasons are totally different; that the wet season prevails in New Guinea between March and October, which on the north of Australia is the driest part of the year; while from October to March, when most rain falls in Australia, it is probable that the south coast of New Guinea has its driest weather."—J. B. Jukes, "Voyage of the Fly," vol. i, p. 157.

Rich as the entire archipelago is in bird life, many as are the species peculiar to this or that island and found nowhere else, it would, nevertheless, be an unjust limitation to enumerate only such forms as are confined to the one region, and cannot without the compulsion of some extraneous force pass beyond the barriers of their island home, to the total exclusion of the many additional species of birds that, while they may not in all cases breed, yet linger for a longer or shorter period in the places of their choosing. A large number of species of swallows, kingfishers, raptorial birds, range so widely as to make it impossible to say that they really belong to one island or group of islands rather than to another. In some instances, therefore, we find an interchange of habitat.

The pigeons form a very large chapter in the natural history of New Guinea. They are many in number and species (more than 80 are known), of all sizes and characteristics, and are found pretty generally throughout the vast island. Many of the kinds distributed in different quarters in Australia are to be seen in Papua, while several are peculiar to the latter and never found in Australia at all. Almost all phases of columbar development, therefore, may be studied in this region, which, ornithologically speaking, is, as has been shown, in divers instances, singularly favored. Foremost among the pigeons is the splendid Goura coronata, whose stately form is now not uncommon in zoological gardens. It is very large for a pigeon, as large oftentimes as the domestic turkey, very slow in its movements and quiet in its disposition. Its lovely dark blue plumage and the peculiar but beautiful crown are its chief claims to renown among the many other wonders of its habitat, while its great size distinguishes it among its own kind. The crest is certainly very remarkable, imparting to its wearer a look that no other species of its tribe, indeed, no other bird, possesses. It has the appearance of a bunch of long, delicate leaves from which all the pulpy matter has been removed. There appear to be rather individual than specific differences in the crests. The crest of Goura victoriae may be thicker toward the top, the thin feathers spreading out into little fans, but this appearance is not invariable. On the other hand, Goura albertisi boasts a crest fully as large and tall, but the spatulas, instead of flowering out as it were, remain of an uneven texture throughout their length. Yet in this case, also, the distinction is not certain. A surer mark of difference between the two species is the white on the wings, this color being particularly noticeable in the albertisi.

A dark gray blue is the dominating color; this becomes paler on the tail, and finally makes a bluish-white band. Whitish marks appear on some of the feathers, while on the shoulders a fine maroon is visible and again on the under parts. The total length of the bird is fully two and a half feet.

Another species, Goura sclaterii, says D'Albertis, "is like the crested Goura, but differs from it in having an ashen colored instead of an iron gray black." Wallace mentions still another species, Goura steursii, from Jobie, brought from there by the naturalist, Rosenberg.

The genus Eutrygon, of New Guinea, is represented by a single species, namely, E. terrestris. This pigeon is a handsome dark leaden gray bird with a whitish spot on the forehead. The wings, tail, back and rump are a shining light olive, the sides and under tail coverts rufous. A white collar encircles the neck and throat; bill small and bony. The smallest of the genus Ptilopus, Ptilopus nanus, is clothed in bronzy green, set off by a strip of gray on either side of the neck, by a patch of purple in the very middle of the abdomen and yellow touches on the wing coverts. Tail deep green; bright corn yellow on under tail coverts. Female has no purple spot. The tiny fruit pigeon it is called.

Another pretty little pigeon is Ptilopus iozonus, purple banded; this dainty miniature of its family is about eight inches in length. The general color is green, becoming black along the extremities of the long wings. The tail beneath is yellow, buff and white; legs yellow.

The Chalcophaps margaritae (Philogoenas jobiensis)

or white chested pigeon strikes one at first as being brown or bronze in color, but further observation will show a greater variety of tint. Moreover, as with almost all pigeons, the fundamental color is rich with its reflected lights. The tail is black intermixed with blue, the head black and gray, the neck, breast and throat white. Elsewhere violet, blue, even pink, are reflected from the uniform metallic brown surface. This pigeon is small in size, timid and suspicious, and keeps to the ground, rarely perching upon trees.

A fine, large bird, nearly two feet in length, is Macropygia reinwardtii, widely distributed over the archipelago. The under parts, including the neck and head, are pure white or ashy. Above, over the back, wings and two middle feathers of the long and shapely tail, the color is a warm chestnut. Black occurs also on the primaries, and in lines and edgings along some of the tail feathers mixed with gray. The feet are red; around the eye runs a circlet of bare skin.

Otidiphaps nobilis, a ground pigeon, is rich in color. On the long feathers of the head a dark green lies; around the neck runs a collar of green rippling with light. A rich brown darkens the metallic surface of the back, while the wings are coffee colored. The curiously rounded tail is a dark blue black and contains twenty feathers. The note of this bird is strenuous and persistent, lacking perhaps the volume of certain species, but making up the deficiency by iteration and reiteration. The bill is like a small bone.

To D'Albertis we are indebted for a brief description of Gymnophaps albertisii, novum genus et nova species. "The form of their beaks, the nostrils surrounded by a circle of the brightest scarlet, and a large bare space around the eyes of the same brilliant color, give these birds a most curious appearance. The back is generally ash colored, speckled with black at the ends of the feathers."

Among pigeons, indeed among all the feathered folk, there are few more curious looking birds than the species Caloenas nicobarica, Nicobar pigeon, representing a genus by itself, scattered more or less abundantly throughout the Malayan Archipelago. It possesses considerable power of flight, although not an easy bird upon the wing, hence its general diffusion over the numberless islands of the Australasian seas. Mr. Guppy records its appearance in the Solomon Islands. The anomalous feature causing the peculiar appearance is the spread of long individualized feathers over the neck, shoulders and back. Thus is formed a kind of disparted mantle in which the lanceolate plumes seem to have been thrust after the subjacent layer was grown. The reflections from this singular covering are a blending of bronze and green. A still brighter reflection is turned from the metallic surface of the wings, a livelier green here meeting the eye. One notices with some surprise, as if it were an incongruous appearance, that the terminations of the tail feathers are a pure white. Everywhere else we find a uniformity of bronzy coloring, intense indeed with reflections, but without contrasts.

Many of these pigeons, especially of the crowned species, are most delicious eating. The flesh surpasses in flavor, richness and other edible qualities that of almost all game birds. According to the taste of some travelers turkeys, ducks, geese, all must hang their heads in the presence of Goura coronata.

The Talegallus or brush turkey is frequently seen in New Guinea, his mound being one of the characteristic features of the country. He is a small bird to accomplish such a task as gathering together in a compact mass, material—brush, dirt, leaves, etc.—in sufficient abundance to fill 20 or 30 large carts. No two travelers seem to make the same measurements. In this, which he treads down firm, the eggs are deposited and then left for the incubation the heat of decaying matter is sure to bring about. Several nests are placed in the same mound and do service for successive seasons. It is very much as if one of our barnyard fowls were transported into the depths of the forest, since the general aspect of the domestic hen and the wild bird is almost identical, and the cackling equally serious and obdurate.

The muscular effort necessary to do the heaping up of the mounds must of course be very great; most of the work, if not all, is done by means of the foot, which is of large size and terminates in a long, stout leg. While the bird stands on one foot, with the other he grasps the materials to be used and thrusts or kicks them back to the place he wishes. In this way the huge nest is gradually formed until it becomes a very respectable hillock in its dimensions, in some instances 20 to 30 feet through and 15 in height; all this is accomplished by birds (several combining together to perform the task) scarcely larger than a barnyard fowl. This Megapode (not using the term in its strict scientific limitation) is not addicted to flight nor are its wings of sufficient strength to keep it long in the air even were the bird disposed to intrust itself to that element. Accordingly when disturbed, if it takes to its wings at all, it is with hurried and laborious strokes usually terminating at some convenient bough not far away, where it stands with outstretched neck somewhat after the manner of our wild turkey, anxious as to the cause of alarm below. It is a shy, timid bird, attentive to its own business solely, yet, like all such creatures, frequently carried away by curiosity.

Its enemies are many, for the flesh is sweet and the eggs nutritious. It would seem, therefore, as if for this defenseless, inoffensive creature, Nature would have provided some special protection. So indeed she has, since in the dusky hue, that blends readily with the forest surroundings, the Talegallus is furnished with the best possible protective coloring, but Nature oftentimes appears to delight in being capricious or inconsistent; she here gives an invisible cloak, but as if to neutralize the gift, she bestows also a loud, dissonant voice that invites everything within hearing to come and see to what it belongs; and, as if this were not enough, the poor creature is obliged by hapless fate to call public attention to the depository in which its treasures are laid, by the vast size of the structure erected for their concealment.

The general color of the birds is a sober brown, unrelieved by any touch of brightness, unless it be in the pale yellow of the legs. The neck of one species is flushed with red, while in another a warm dark gray reaches as far as the abdomen. In some cases a delicate shading of browns produces a pleasing effect on the body and wings. The bill is dark, short and compact.

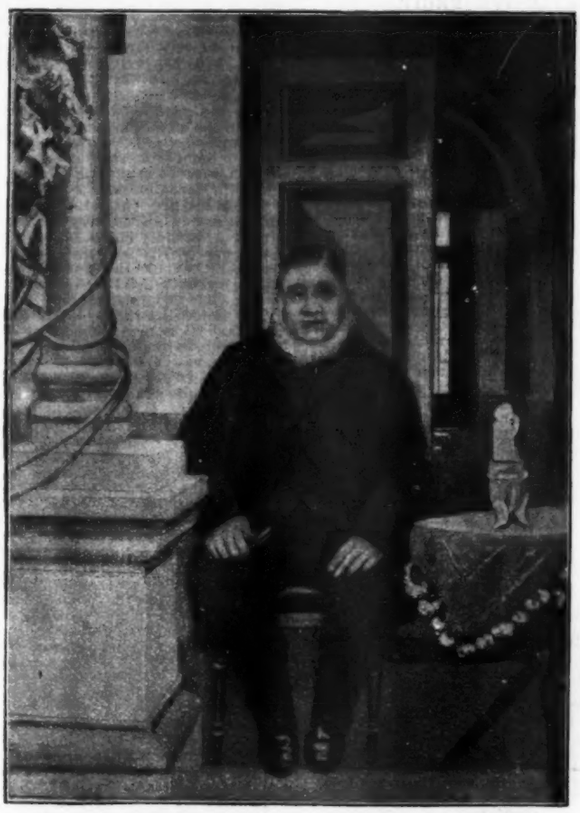
Four species are known, namely, Talegallus lathamii of Australia and New Guinea; T. jobiensis, T. cuvierii, and T. fuscirostris. D'Albertis calls the last nova species. It would seem as if some or all of these might be domesticated. The first mentioned is a large bird, in shape and size the counterpart of the female turkey, of a uniformly dark brown plumage and long neck denuded of a compact covering of feathers, but having instead a coarse dull red skin scantily clothed with short, stiff feathered shafts. The head presents a similar appearance. The tail is long and keel-shaped, and like the wings dull of hue. There is a slight interfusion of gray on the under parts, imparting a mottled appearance to the thighs and abdomen. Yellow brightens the wattles. The female is like her mate, but somewhat smaller. The eggs are pure white, laid in a wide circle, and about 3½ inches long.

Talegallus cuvierii is also a very dark brown with yellow legs and feet. It is not nearly so large a bird as the preceding and is better put together. While the larger bird looks not unlike a loosely set, shambling turkey, the smaller might pass for a trim plump pullet. The sexes present no special differences. The color throughout is a sooty brown excepting on the abdomen, which is mottled. The back and hinder parts are covered with a thick bed of the softest down, like the feathers a dark brown.

Talegallus fuscirostrii has been assigned a separate species of its own on account of its dark colored bill.

T. jobiensis from the island of Jobie is a variation probably differing but slightly from the species enumerated.

In Dasyptilus pesquetii we see a bird which must be classed among the parrots, yet one which possesses a curious resemblance in that most distinctive feature of the parrot family, viz., the head, to hawks and eagles; the eye also is small and fierce, and the beak that of a bird of prey. The feathers too, what feathers there are, for the head is almost bare except the occiput, stand out stiffly as at times of anger those on the head of the eagle. But in all other points the parrot is evident enough. The colors are strongly laid in, although



THE LATEST PORTRAIT OF PRESIDENT KRUGER.

(Photographed at the door of his house.)

RAPID TRANSIT IN THE TRANSVAAL—PROSPECTORS ON THEIR WAY TO THE MINES.

few in number. Black of a greenish tinge covers most of the upper parts, from which the red of the wings stands out vividly; a similar tint scarcely less brilliant appears on the thighs, abdomen and rump; a grayish hue is apparent on the breast, combined with pale yellow, giving a peculiar cast to that part of the body. In length, taking in the somewhat long tail, this anomalous member of his tribe is about twenty inches.

If the parrot just described is something of a nondescript, the black cockatoo, Aterrimus, is exceptional because of his great size, for he is the largest of his family. He is also the only member of the genus Microglossus. He is to be found pretty generally throughout the archipelago and is always in evidence because of his size, color and eccentricity of looks and conduct. He measures sometimes 32 inches and is entirely black from his absurd head, which is finely crested, to the long, rounded tail. The only relief to this funereal garb is the bright red of the bare cheeks. The bill is extremely powerful and is used with as much dexterity by its proud possessor as if it were not the most awkward looking thing in the world.

A splendid species of the Gardener, splendid by reason of its crest, for in other features it resembles the Inornata, is Amblyornis subalaris, found in the Astrolabe and Horseshoe Mountains, southeast New Guinea. One noteworthy fact should not be omitted; its cabin boasts of two entrances, for what special purpose, if any, is a matter of surmise. There is considerable olivaceous on the body of this species and bright, fine stripes on the throat. The beautiful erectile fire-orange crest, tall and spreading, grows dark of hue near the crown, and is also shaded here and there along the sides. The bill lacks the size of the other species. The total length of the bird is only about eight inches. The female is like the male with the exception of the crest. She is without this distinguishing ornament, but the uniform dark brown of the back and the mottled brown yellow below are the same.

The bower of this species is said to surpass that of any other bird in ingenuity and quaintness. The same general design as we have seen in the case of the Inornata is followed by the Subalaris. Around a central post or tree stem the construction is reared; at its foot is a bank of moss into which is thrust flower or twig or other ornament. The running or chasing ring encircles the bank, and over all there is erected a sort of roof probably as a shelter and concealment. Surely instinct or sagacity has not further gone than in this little pleasure house built as it were after a plan, out of material as serviceable and durable as the special purposes required. Easily removable, they are at the same time fitted in the entire work so artistically as to give the appearance of solidity to the fabric.

Ten years ago there was discovered in the Horseshoe Mountains, eastern New Guinea, a fine Paradise bird, regarded as a new species of a new genus and so classified by the distinguished German naturalists Drs. Finsch and Meyer, whose personal knowledge of the great island and its feathered population is so widely appreciated. They named the acquisition Astrarchia Stephaniæ after the Crown Princess of Austria. It is like the brilliant Astrapia nigra, but differs in some particulars so important, especially in the form of the tail, as to justify its relegation to a genus of its own. The general color is black with violet, green, bronze and blue reflections. There are two, if not three, bands athwart the breast, the one glinting out all the reflections, the other just below, less broad, glowing with a coppery refulgence, while a third, so evanescent as to scarcely admit of specification, is of a bluish shade. The under parts do not fail from their dark surfaces to send forth gleams of changing colors—green, golden and brown. The tail is black also, upper and under tail coverts blue black. From the side of the head proceed velvety black, shining feathers somewhat lengthened; so too are the loose feathers on the neck. The metallic wings—black and glistening—are of a violet purplish cast. The bill, feet and irides are black. As in the Astrapia, the exterior upper tail feathers are curved back at their ends and are of a roseate dye, perceptible but elusive. But it is not in the tints, but in the arched shape of the tail feathers, that one essential difference between the Astrapia nigra—the Paradise Pie—and Astrarchia lies. In the first "the tail is regularly graduated," in the second "the graduation is irregular." Again, the head of the latter is less profusely plumaged, nor are the feathers of adornment as long as in the allied genus. On the neck the plumes of Astrarchia are not free and upturned, but laid close upon the underlying feathers.

ICE CAVES OF JAPAN.

SOME eight or nine miles from Shoji, in the woods, says a correspondent in Public Opinion, is the entrance to the great ice cave we had come so far to see, a natural circular depression or basin in the ground in the middle of the forest, some thirty yards across and about forty feet deep. At the foot of one of the sides is a dark opening in the lava, a few feet down which may be seen the top of a wooden ladder. This is about twenty feet long, and at the foot of it are a heap of blocks of lava, down which we scrambled for some thirty or forty feet more, till a floor of solid ice, more or less flat, was reached. Very careful progress along this had to be made to avoid slipping down and extinguishing the torches. For the first fifty yards frequent blocks of lava rise through the ice of the floor, while further on there is nothing but ice. The lava roof is sometimes thirty or forty feet above one's head, sometimes only four or five feet from the floor. The light of the torches glanced continually on icicles many feet long pendent from the roof. Presently we passed some large blocks of ice, which had been cut by the country people for sale at Kofu, some miles off. At nearly four hundred yards from the entrance about twenty wonderful ice stalagmites, from two to five feet in height, rose from the floor close to a lava wall forming apparently the end of the cave, to meet icicles hanging from the roof, from which water at this time of the year continually drops on to them. The tops of these stalagmites form hollow bell-shaped cylinders, giving out a faint note like a gong when struck; they are partly filled with the water which drips on to them from the icicles above. Soon by the side of them, on the left, a low arch in the lava on the level of the floor, about three feet high, may be seen. Down this is a strong current of air; there is a rapid descent for some thirty-five feet, and thence the course of the cave has been followed for another two hundred yards or so, but owing to the strong current of air which constantly extinguishes the torches, and the smallness of the passage, which slopes down rapidly from the entrance, no detailed description of it can be given; but undoubtedly the cave runs on for some distance, perhaps to another outlet, for the current of air is very strong at the extreme point to which anyone has yet penetrated.

AN EXPLOSIVE FRUIT.

A CORRESPONDENT of the editor of La Nature recently sent him from Batavia a number of dry fruits having the form and color of cigars and about an inch in length. These fruits have the singular property of exploding with a noise when they are put into a vessel containing water. In fact, if one of them be left to itself under such circumstances, it will be observed to rest upon the surface of the liquid for two, three or five minutes at the most, and then to burst with violence in projecting one of its two valves, as well as most of the seeds that it contains. There is no need of saying that these fruits burst through a phenomenon of elasticity. Thus, the fruit opens through its contact with the water, as shown in the upper right hand figure of the accompanying engraving.

The Acanthaceæ, the family to which the specimens belong, has fruits composed of two carpels, the opening of which in a state of maturity takes place from apex to base, thus forming two divergent horns starting from the same point. When the fruits ripen upon the plant, the opening occurs with a slight noise and a portion of the seeds is projected, but much less violently than when the carpels are put in water. In the latter case, the liquid is easily absorbed by the dry but permeable tissue of the surface of the fruit, especially in the grooves that correspond to the lines of separation of the two valves. Now, since the internal tissue is hard and ligneous, and not in equilibrium with the external tissue, which has just been abruptly softened, the tension exerted by the first causes the violent opening that we observe in the glass of water.

Nor are the seeds themselves devoid of interest. As

EXPLOSIVE FRUIT OF THE GENUS JUSTICIA.

soon as they are in contact with water, epidermic cells forming a sort of crest exhibit themselves immediately around each of them. These cells resume the form that they possessed in the fresh state. They are mucilaginous and cause the seeds to adhere at once to any object with which they come into contact.

In the vegetable kingdom, we find a certain number of fruits that are explosible by various processes, and that belong to diverse families. The object of their bursting is the dissemination of their seeds. It is remarkable in the Balsamines, which on this account are called by botanists Impatiens. Many leguminous plants, as well as certain cucurbits (Momondica, Ecbalium, etc.) belong to the same category. Finally, the sand box tree (Hura crepitans), of the family of Euphorbiaceæ, opens its fruit with a loud report and breaks in pieces such fragile objects as are within range of its carpels, which are projected in all directions.

The fruits under consideration must be referred to the genus Justicia, and probably to the species grandiflora, as far as it is possible to judge from these single elements of comparison. The phenomenon, however, may be obtained with other fruits of the Acanthaceæ, but not so well as with the species just mentioned.—La Nature.

PRUNING OF STREET TREES.

THE Parking Commission, of Washington, has been in existence for more than twenty years, and the same men who were appointed at the beginning, W. R. Smith, William Saunders and John Saul, are serving on it still. As might be expected from the work of an intelligent body, much valuable information has been accumulated, especially as regards the system of pruning adopted. It has been the custom of the Parking Commission, when planting three or four year old trees on the streets, to head them back to a height of about nine feet from the ground and shorten in all laterals branches. This has worked satisfactorily, as it tends to make the tree push out fresh growths, and at the end of the first year the trees look as if they had not felt the change.

It is in the treatment of the trees, after they have attained the age of a dozen years or more, that the results of the different methods of pruning are so very noticeable. For example, the occidental plane, if left to itself, will grow very irregularly, become sickly and then invite attacks by scale insects, which soon threaten to kill them altogether. On several of the streets, a few years ago, this was exactly the condition of these trees. Heroic measures were decided upon in the way of cutting back the branches to within a short distance of the stem. This was carried out on several miles of streets, much to the horror and dismay of the property owners, who declared that the members of the commission had suddenly turned insane. The commissioners said nothing. Probably they had some doubts as to the results of the experiment. The treatment proved to be the proper one, however, and within two years from the date of pruning, the streets where the pruning was done had the most beautiful trees in the city. The oriental plane grows into a more symmetrical shape and does not need the knife so often to keep it in shape or to give it new vigor as does Platanus occidentalis.

North Carolina poplars, which have been pruned severely because their branches have become straggling, are refurnished very quickly after pruning with strong growths. These growths appear well for the first part of the season, but after a period of dry weather they are the first to lose their leaves, while those poplars which have only been moderately pruned retain their foliage much longer.

The maiden hair tree, Ginkgo biloba, has one marked peculiarity. Some specimens after planting stand still and absolutely refuse to grow. Most of the trees make an open growth, as may be seen on the avenue between the Department of Agriculture and Pennsylvania Avenue; these trees have never been pruned, and some of them are little more than straight sticks, although it is something like fifteen years since they were set out. On the other hand, those trees planted on the west side of Lafayette Square and on Pierce Street are ideal specimens, owing to the fact that they have been shaped on several occasions.

The silver maple does not last in a healthy condition for more than sixteen years as a sidewalk tree in Washington. As the natural soil is not of the best, when the holes are dug the soil taken out is carted away and new and better material takes its place. This keeps the tree in good health for several years, but when it gets beyond certain dimensions it, of course, begins to show signs of starvation in the losing of the lower branches and ripening great quantities of seed annually. The only way in which the life of the tree is prolonged for a few years is by cutting it severely in to the main stem. This is done in the early spring months, and before summer is over the tree is pretty well furnished with a profusion of fresh growths.—Botanic Garden, Washington, D. C.

—G. W. O. in Garden and Forest.

THE BURNING TREE OF BURMA.

THERE has lately been added to the collection of plants at the Botanic Gardens, at Madras, India, a specimen of a strange tree. It is in size scarcely more than a bush, says Public Opinion, but others of its species are known to have attained in their habitat in the Himalayas, Burma and the Malacca Peninsula, the dimensions of a large tree from fifty to seventy-five feet in height. The Madras specimen is surrounded by a strong railing which bears the sign: "Dangerous! All persons are forbidden to touch the leaves or branches of this tree." It is, therefore, a forbidden tree in the midst of the garden, but no one is tempted to touch it, for it is known to be a "burning tree." This name is a misnomer, for the tree stings rather than burns. Beneath the leaves are stings comparable to those nettles which, when touched, pierce the skin and secrete a fluid which certainly has a burning effect. The sting leaves no outward sign, but the sensation of pain persists sometimes for months, and is especially keen on damp days or when the place which has been wounded is plunged in water. The natives in the parts of Burma where this tree grows are in such terror of it that they fly in haste when they perceive the peculiar odor which it exhales. If they happen to touch it they fall on the ground and roll over and over on the earth with shrieks. Dogs touched by it yelp and run, biting and tearing the part of their bodies that has been touched. A horse which had come in contact with a "burning tree" ran like a mad thing, biting everything and everybody that it could reach. A missionary at Mandalay, who investigated a leaf of the plant with his forefinger, suffered agony for several weeks, and for ten months felt occasional darting pains in his finger.

PLANS FOR BENEFIT OF BOTTLE MANUFACTURERS.

THE Secretary of State has communicated to Congress a plan for the benefit of the glass bottle manufacturers of the United States, and has sent to Congress a letter from the United States consul at Belfast, Ireland, who, after calling attention to the vast and increasing quantities of ginger ale, porter, ale, stout and beer imported into the United States, says that it all comes in bottles made in England and Germany, while it might be just as well brought to this country and sold to the people who bottle the wet goods. The consul recommends an import duty of one-half or three-fourths of one per cent. on bottles containing ginger ale, porter, stout and beer, this duty to be rebated when it is shown the bottles are of American manufacture. The consul says: "If such an import duty were placed upon our statute books, two very large and influential interests would at once exert their best efforts to extract whatever advantage there would be in it. I refer to the domestic manufacturer and the consumer. Both would bring their influence to bear upon the dealer, who, in turn, would demand that the imported article be put up in American made bottles." It is probable, says the American Carbonator and Bottler, that a bill to carry out this recommendation will be introduced at once and urged before the Committee on Ways and Means.

THE NEW POET LAUREATE.

MR. ALFRED AUSTIN, the new poet laureate, was born at Headingley, near Leeds, in 1835. His father was a merchant and magistrate of Leeds. Mr. Austin was educated at Stonyhurst College and St. Mary's, Oscott. He graduated at the University of London in 1853, and four years later was called to the bar of the Inner Temple. In 1861, on the death of his father, he went to Italy and published a volume of verse in the same year. Among his subsequent works have been "The Human Tragedy," in 1862. "The Golden Age," in 1871, and between 1881 and 1890 half a dozen volumes, including "Savonarola," in 1881, "Prince Lucifer" and "English Lyrics." His latest work was published recently, and is entitled "In Veronica's Garden," and is a sequel to "The Garden that I Love." In addition to his work in literature, Mr. Austin has for many years written for the Standard, and is recognized as a most able and accomplished journalist.

Mr. Austin's house in the County of Kent, Old Swinford Manor, is one of the most charming old houses in Kent. In "The Garden that I Love" and its sequel, "In Veronica's Garden," Mr. Austin has described his lovely home, with its surrounding beauties of quaint garden and spreading meadow land, in a manner that will be familiar to many of our readers. Old Swinford Manor is a house with an historical record. Before the reign of Henry V it was in the possession of a family who took their name from the manor, but during the time of that monarch it was held by a family named Bridges, who were descended from Johnatte-Brigg, "one of those eminent persons," says Hasted, "whose effigies, kneeling and habited in armor, were painted in the window of Great Chart Church." The manor was held by them until the reign of James I, when the Bridges of that day sold it to Sir Nicholas Tufton, who was afterward created Earl of Thanet. The second Earl of Thanet looked

MR. ALFRED AUSTIN, POET LAUREATE.

with an eye of favor upon certain lands belonging to his neighbor, Nicholas Toke, of Godinton, ultimately exchanging Swinford for them. The Toke family kept possession until the close of the last century. Hasted says that the manor, once called Swinfoot, but more properly Swinford, probably took its name from some ford across the River Stour, which runs near by.—We are indebted to the St. James's Budget for the portrait and article.

CHEMISTRY AS A GENERAL EDUCATION.*

By PETER T. AUSTEN, Ph.D., F.C.S., Professor of Chemistry, Brooklyn Polytechnic Institute.

THE parent who finds his boy rapidly growing into manhood, and who has realized, through a more or less unsatisfactory if not a stringent experience, how little his own education has enabled him to grapple with the real problems in his life, asks himself many questions about the nature of his boy's studies. Will they fit him for real life? Will they enable him, not only to use his powers to advantage, but to utilize to the fullest extent the opportunities that may present themselves during his journey through life? The parent, if an educated man, knows full well the value of special knowledge. But he also knows that goods may have but little value if the market is overstocked, that pyrites may be mistaken for gold, and that a shot gun does better work with small game than the finest rifle.

If the boy shows a marked fondness and aptitude for chemistry, the problem is not a difficult one to solve. Make a chemist of him. That men may study chemistry and fail as chemists cannot be denied. A vocation in which all succeeded could not be called a profession, and the profession of chemistry is not an easy one. It requires, aside from the ability to observe and compare accurately, as much, if not more, varied knowledge than any other. This is especially true of chemical engineering, in which not only chemical knowledge, but an acquaintance with mechanics, electricity, heat and steam, as well as an understanding of the art and science of manufacturing, and not a little else is called for. But in a country that has such vast resources as this, one which is destined in due time to be the supplier of the world, there will never be a lack of opportunity for chemists of the right sort.

And even now, and for some years past, the demand for well educated young American chemists seems to have been in excess of the supply. I do not mean that a young man who has had a short course in analytical chemistry and a meager drill in general chemistry can expect to find a dozen places awaiting him, although it is surprising how often such young fellows do succeed in starting off. I mean that a young man who has had a thorough training in the science and art of chemistry will find his opportunity if he seeks it energetically and persistently, and does not demand the whole surface of the earth and of the celestial dome for the field of his first activity in practical work.

It is not a little interesting for one who has been a teacher of chemistry for a number of years to watch the progress of his students after they enter their profession, and to note what different paths they follow. Aside from chemical manufactures proper, almost every manufacture, after it reaches a certain magnitude, requires a chemist, or at least a man with some chemical knowledge, for it deals with various kinds of matter, most of which demand analytical examination or comparative testing to determine their composition and value. Most manufactures consist in converting some kind or form of matter into some other kind or form. Here, again, the chemist is called on to study the principles involved, to remedy faults, to improve and invent new methods and products. And, when waste products accumulate, the chemist is again called upon to find methods to utilize them or dispose of them. I might write many pages about the manifold nature of the demands made on the chemists by the manufacturers. The coal has to be analyzed, else it may fall below the standard guaranteed, and the steam will cost too much. The lubricating oils need continual testing. The water scales the boiler, and the coal bills increase enormously; it must be purified. Adulteration, sophistication and other forms of commercial dishonesty so commonly practiced are kept in check by the chemist. In many manufacturing processes every step is controlled by analysis.

In the agricultural experiment stations hundreds of chemists are continually at work analyzing fertilizers, milk and farm products. Soils are examined, and live stock, and what they eat and eliminate are analyzed. The boards of health and the geological surveys also keep a number of chemists busily at work. In the iron and steel industries a swarm of chemists test and analyze the raw materials, the substances in process of manufacture and the finished products. Metals are sold on certificates of analysis. In the packing industry, lard, oil and many other products now pass through the hands of the chemist. In the textile industries the dyes are tested: fabrics, mordants, sizes and what not are examined. Many railroads have their own laboratories, and buy material on specifications made out by skilled chemists. No manufacturer knows the whys and wherefores of success and failure of the processes as well as the chemist; on him falls largely in the struggle of competition the responsibility of saving the industry. And if he combine both chemical and mechanical abilities, he may develop and superintend a great manufacture, improve its processes, invent new methods and new forms of apparatus, and successfully conduct an immense industry.

Thus it is not only in the laboratory that the chemist finds occupation, but also as manager or superintendent of the works. And, again, who is so competent to enter the business department of manufacture as the chemist, who is familiar with every detail of the properties and production of the article bought and sold? Who can sell them as well as a chemist who has the selling faculty, and who knows much about them that no one but a chemist can know? Hence many a chemist finds his way into a responsible business position.

It goes without saying that in every town of any size an analytical chemist will be found. In large cities the professor of analytical chemistry covers a wide field, and in many cases develops an elaborate organization, employing a number of assistant chemists and skilled workmen, and doing a business well up in the thousands.

It is a fact which is perhaps not fully appreciated, that the most difficult part of a business is not the manufacturing but the selling of the goods. In organizing a manufacture skilled and able engineers, superintendents, and chemists, bookkeepers and the best of labor are engaged. Experienced and adroit men are placed in management of the business. But all of these are not more difficult to obtain than successful salesmen. It is unnecessary to say that a manufacture cannot be carried on unless the products can be sold. Men who are intelligent, tactful and well educated, and who thoroughly understand the articles they sell are not easy to obtain. In this matter an important change is working itself out in this country. The ignorant and blatant salesman, ready to bribe the prospective buyer or his employes if he could, and to dispose of the poorest goods at the highest price, was common in former years. While this state of affairs still continues in some branches of trade, it has to a great extent been corrected as regards the selling of articles that can be tested chemically, and when it can be shown by experiment which one of several articles gives the best result for the money. Large concerns have lately taken graduates from the leading scientific schools, educated them in the business, and if they have developed mercantile ability, have put them in the sales department. The results, so far as I can find out, have been surprisingly good. But out of a considerable number of young men only a few develop the gifts and qualities of the successful salesman. Others who have been trained in the manufacture find places for their activities in the manufacture or in the business. From requests sent me by large concerns for bright graduates to work into their sales departments I judge that this movement is on the increase, and it certainly will afford the young chemist an additional opportunity for activity.

I should not omit in this category the profession of teaching. In recent years the development of scientific education, both in colleges and schools, has been very great. There are few colleges of any standing that have not a course for elective in chemistry; and school courses in experimental chemistry and elementary analysis are becoming more and more common. Many young chemists find in them most fruitful opportunities for activity and development.

But it is my particular object in this paper to speak of the study of chemistry as a liberal education for those who do not intend to become professional chemists, but who may enter mercantile business, or other vocations not chemical, in which this education may not at first glance appear of any practical use.

In some of the professions, indeed, it is of the first importance. For the physician a thorough knowledge of chemistry is absolutely necessary, if he would know the nature of the remedies he administers, and understand the change and the products involved in the living organism. He must be familiar with physiological chemistry if he hopes to attain his due measure of success. The lawyer finds that in cases dealing with manufacturing processes, nuisances, patents, mines, commercial products, in certain criminal cases, and numerous others, a knowledge of chemistry is obligatory. This knowledge, I may add, is most difficult as a rule, to attain late in life. And not only the physician and the lawyer, but some theologians whom I know would be greatly benefited by a fuller understanding of chemistry.

When I speak of chemistry as an education, I particularly wish not to be misunderstood. The student in chemistry is not to slight the broad foundation on which all education must be based. His education in mathematics, grammar, history, languages, metaphysics, psychology, natural science, etc., must be full and thorough. His physical training must be carefully attended to. He will have to spend more afternoon hours in the laboratory and less time in sport, and hence he may have to take especial care of his body. But experience proves that young men are able to do this, study and still keep in the best of health and spirits, and be able to utilize the months of summer vacation to their fullest extent.

BENEFIT OF LABORATORY STUDY AND TRAINING.

This leads me to speak of the first benefit to be derived from a course that demands work outside of the usual recitation and lecture hours, which is an experience in self-denial. We have about so much time allotted to us in this life. We cannot have all of it for both work and play. Chemical study and experiment take time. The unfinished experimental work cannot be hastened or crammed. It cannot be evaded or dissembled. It cannot be dishonestly made up. The happy guess does not assist it. An examination cannot replace it. If it is to be really done, the brightest mind cannot escape devoting a considerable amount of time to it. Something may have to be given up for it; it may be the athletic field, the theater, the social gathering; in any case, one must deny one's self something. And very large does the sacrifice often appear to the young man. I do not undervalue recreation. But to enjoy recreation fully it must be contrasted with work. And one of the first things a man must learn, would he be successful, is that, in order to do a few things well, he must deny himself many pleasures; sometimes even what he may consider necessities. Then slowly, but surely, he begins to realize the fact that time is his main capital. He perceives the necessity of steady, untiring and persistent daily work, which genius may illumine, but cannot replace. He learns to appreciate how limited is the time at his disposal, when the hours for sleep, meals, social duties and necessary rest have been deducted. But

* A paper read before the Students' Chemical Society of the Polytechnic Institute, November 4.

his self-denial brings a sure reward. His growing knowledge of matter, its properties and its changes, his beginning insight into cause and effect, his experience in acquiring a mastery over certain kinds of matter and making them subject to the power of his mind and skill, awaken in him new and indescribable feelings. As his laboratory work goes on he becomes acquainted with the properties and behavior of many kinds of matter. He acquires skill in manipulation and construction. He works with poisons and explosives and learns caution. No amount of reading or attendance at lectures can take the place of this knowledge acquired by personal observation and practice. But, on the other hand, the education by reading and lecturing should not be curtailed. Each has its proper place, and neither can be omitted from the curriculum of the course. He forms higher ideals about what it is possible to get out of life. He begins to measure men by new standards, and to acquire a better appreciation of those who mould humanity, to whom the progress of civilization is so largely due, and to whom mankind is so deeply indebted.

The lesson that duty to one's self and mere pleasure are in continual conflict is an important one for a young man to learn, and it is rarely learnt or realized until he has come into actual contact with practical life, and has tried to draw interest on a capital perhaps greater than he really possesses. But the lesson once learned leads a man to find pleasure in his work, and adds a zest to recreation. I may add that I doubt if hard work ever hurts any one very much. It is worry and anxiety that tire men out.

In order to make my theme easier to follow by those who may not be familiar with the character of a chemical course, I will consider some of the results obtained by the study of the various subjects, taking them up in the order usually assigned them in a course of chemistry.

The course generally begins with the practice of experimental chemistry accompanied with suitable instruction in the lecture room. The student studies the properties and behavior of matter experimentally, training his faculties of observation in a way unapproached, I believe, by any other subject. The form, color, odor and tastes of the substances are observed and noted. Their behavior under certain conditions is carefully studied. Questions are put which must be worked out experimentally. Not only are the faculties of observation developed and trained, but an education of the greatest value is given in accuracy of thought.

Not a few of the people one meets ordinarily are neither entirely honest nor by any means accurate. Both their honesty and accuracy are more or less befogged by ignorance, credulity, prejudice or self-interest. Neither does the average individual observe accurately. He seldom sees much that he is not looking for, and his observations rarely contradict his expressed views. To such a man, a course in experimental chemistry, even if taken late in life, is of value, if it effects nothing more than to compel him at certain times to get near to facts.

Another valuable element of this form of education lies in learning by experiment the Protean changes which matter suffers when subjected to different conditions, and the exactness of the working of the laws of nature. This compels a close attention to the conditions under which the phenomena are observed. The student is impressed by the changes that matter may suffer on the alteration of a single condition—perhaps a condition apparently so insignificant as to escape notice by an untrained observer. The danger from loose generalizations is made manifest, and also the dishonesty of reasoning based on partial and unfair selection of facts. Plutarch tells us of a public man named Annius, who had no great repute for justice or temperance, but who was famous for confusing honest men by adroit argumentation. The study of physical science would never produce an Annius.

Training in manipulation is another important feature in the laboratory work. It is painful to see how clumsy-handed many young men are when they begin their laboratory work. As most of the apparatus has to be put together by the student, cocks which do not fit tight, glass tubes which are not bent just right, and other numerous details have a crucial effect on the results of the experiments. It is sometimes amusing to witness the rage, but ill concealed, that often accompanies—especially if he has an absorptive, rather than a productive mind—a young man's dawning perception of his inability to do a simple thing. That he can decline cork in four languages does not enable him to keep the cork knife in the cork and out of his flesh; nor does his knowledge of the mathematics of a cylinder enable him to cut one out of cork which will fit tight and deliver the contents of the flask into the receiver rather than over his face. The education in manipulative skill is not to be undervalued. I have not a word to say against languages and mathematics. The more a student can get of both of them the better, always bearing in mind that the value of a man depends not merely on what he knows but on what he can do. But a man who can handle only a pen is poorly equipped for the actual life of the present day.

In the various branches of qualitative analysis we have a form of mental training with which I know of no other to compare. It seems to stand alone. The student learns the properties of the commoner elements and their compounds by experiment, and by these properties he recognizes them. But as many of these properties are not observable when several substances are mixed together, it becomes necessary to separate the substances systematically. The methods used for this purpose are models of ingenuity.

The study of qualitative analysis demands a large amount of exact observation, and the retention of this knowledge in the mind. The facts thus acquired must be compared, and some common property used to make the broad groupings; these are again and again subdivided on the same principle, until the substances can be detected with certainty. The element of exactness in work is further developed by the study of this subject. The separation of the various substances from each other has to be done with great care and thoroughness, else the results will be uncertain. In this procedure keen observation, careful comparison and clear reasoning are demanded, and the facts must be obtained by the student himself. This dealing with facts is of great importance. If he fails to observe exactly, if he overlooks some property of the substance he is examining or is careless or slovenly in his manipulations, his results will be inaccurate, and a considerable amount of work may have to be done over again. After a while a respect for his own work is developed. For every step and operation there are reasons, and to explain these a good deal of study is required. All the time he asks: "What substance is used? How is the operation performed? Why is this done?" Important facts are recognized by small clews. The mind and faculties of observation of the student are kept constantly alert and at work. It marks an important point in the education of a young man when he is able to demonstrate by experiments made by himself that he is exact. It involves the elements of personality and independence. To know that he is able to ascertain the composition of many of the innumerable forms of matter about him brings him into closer touch with nature. There is a sense of power in this knowledge which it is hard to describe, and yet it can often be discerned.

I believe it is a common and natural quality in young people, and by no means eradicated in older people, to deceive themselves about the quality of their knowledge or their abilities. It is one of the most important objects in teaching to so inspire the young that they may keep in touch with the work of great minds, and yet not get discouraged at the weakness of their own efforts.

Young people are quick to perceive how easy it is to humbug others about their attainments and abilities. Having more or less by instinct deceived others about one's ability, it becomes still easier to deceive one's self about it. The exact work in the chemical laboratory is an excellent antidote to undue self-esteem. The properties of matter and the laws that control matter are capable of demonstration by any one who is sufficiently skilled, and any exaggeration, any inexact statement or false conclusion about them is easily disproved. This is so soon learnt by the student that it cannot fail to exert a beneficial influence upon his character. It is easy to deceive our fellows—at least for a time. It is impossible to pervert or deceive nature.

In the study of quantitative analysis the student determines by means of processes conducted with great delicacy and exactness, and weighings made on scales of extreme sensitiveness, the amounts of the various constituents of a substance. In this work every speck of matter counts, and a loss of the minutest amount renders the results valueless. The study of quantitative analysis has a remarkable effect upon a careless lad. To have his work represented by figures assigned by himself is a new experience to him. The delicate but relentless needle of the balance reveals not only the inaccuracy of the work, but the lack in the youth. His self-esteem is often deeply wounded; even his social standing, wealth and popularity are scored by the balance. It is the instrument of exactness. It records one's defects. It cannot be cajoled, bullied or deceived. One may sing to it, declaim before it, implore it, offer to bribe it, but to no purpose. It indicates in figures one's ability to perform operations, for the most part simple, with exactness. I have seen careless boys, who were bright enough to get along in their studies without any injury to their health, manifest extreme surprise when the balance announced their inability to attain exactness. Further surprise and considerable chagrin I have seen displayed when the balance has pointed out an attempt to be dishonest and "cook" results. I recall a remark made by a very bright but extremely careless young fellow (now a most distinguished physician). "The needle of that wretched balance," said he, "is like an immense bee's sting. Every time I go to it some cherished quality is pricked." I really think that the balance was the first real check that that boy's self-esteem had received. Carelessness is often an indication of self-conceit. He was a fellow, however, who was at once aroused by an obstacle, and so before he finished his work in quantitative analysis he had acquired an exactness which was most satisfactory. His other work and the young man himself were powerfully influenced by it. I have had students in quantitative analysis who became so irritated at their failure to obtain exact results that they gave up even football in order to practice the manipulations involved in the analysis.

TEACHING IMPORTANCE OF DETAIL.

In all analytical work there is an element which I consider of the highest importance, and that is practice in the organization of work and division of time. By skillful arrangement of the numerous operations a great deal of work can be done in a given time, and yet with little danger of confusion. This is an excellent training in executive management. One also comes to appreciate the importance of the small detail. Young men are often inclined to underestimate the full value of what appear to be minor details. Experienced men know that success is largely owing to punctilious attention to little things. Again, in quantitative analysis every speck of matter must be accounted for. This principle prevades the universe. Its application in a man's work results in thoroughness, and demands most patient and persevering application. Few young people appreciate quite fully how very hard the men work who achieve success in fields of intellectual labor.

Probably the greatest cause of failure in men is the inability to attain self-control. Without it an intellect is of as little use as a steam engine without a governor. In ordinary school education far too little attention is paid to developing and training this most important quality. The brighter a man is intellectually, and the stronger physically, the greater appears to be the danger from imperfections in self-government, and the inability to concentrate himself on a subject. There is no doubt that while the ability to control one's self gives one an enormous power, it is a quality whose development offers great difficulties. I am far from claiming that any one study can enable a man to acquire this attribute, but I believe that certain kinds of laboratory work are of great benefit in developing it, because such work so clearly shows how easily failure follows the loss of self-control, or in the inability to concentrate one's self upon work.

In the preparation of pure chemicals, the student gains an impressive knowledge of the wonderful exactness with which matter obeys physical laws. The growth of a crystal is revelation. And here, again, failure to bear in mind the smallest detail vitiates the result; analysis proves the substance to be impure and the work a failure. In thus dealing at first hand with nature, cause and effect stand out clearly. The work and the results are one's own. No amount of self-adulation or excuse can make the substance any purer, no adroit quibble or misrepresentation can deceive a chemist about it.

In the various branches of analytical work, the student has a constant opportunity for originality. Much of school education consists in the reception of knowledge, as it naturally must, but it is to be regretted when some original thought is not aroused by the knowledge imparted. In chemical work questions continually arise, to answer which more or less experiment is called for. Each experimental fact indicates many possible experiments, so that under wise guidance, the student is led to question nature. To do this he must devise experiments, select or plan apparatus, originate expedients, and observe and compare phenomena closely. In this way he gets not only valuable practice in avoiding, removing or clambering over obstacles, but his mind gets some training in the application of knowledge, and soon shows signs of becoming productive. It is one thing to absorb knowledge and become encyclopedic, and it is quite another to assimilate it and to bring it to bear on a given subject. The difference between the absorption and assimilation of knowledge is not always appreciated in school education. Power does not consist in the possession of knowledge, but in the ability to use it. In laboratory work a constant application is made of the knowledge gained by study, and a continual demand is made for more. A simple phenomenon will often exhaust the student's knowledge long before he has offered a satisfactory explanation of it. In this way knowledge becomes suggestive and stimulating, and an important force in the development of a mind. The student gets a clearer idea of his mind's strong and weak points. There are few of us who do not know what we can do well, but it is very hard to have to admit that there are certain ordinary things which other people can do better than we—even people of whom we may think but little. But the sooner this is understood the better for us. No man can hope to be respected by others who does not respect himself, and to respect one's self one must be honest toward one's self, which is harder than being honest toward others.

The study of applied chemistry brings the student for the first time into intimate contact with the great manufactures. He learns how a few simple chemical reactions may become the basis of an immense industry. He begins to understand how laboratory reactions are carried out on a large scale, and to appreciate the wealth of mechanical ingenuity that is bestowed on them. He gets some idea of the elaborate organization of a manufacture. He appreciates the loss involved in waste products, and discerns the close relations that may exist between side products. He visits large works and sees the men toiling at their tasks, sees thousands of horse power of energy guided by a boy's hand, sees many tons of material speeding through the course of manufacture. He appreciates the immense power of capital which can build the costly plant, and of the still greater power of the brains that can solve the numerous problems and control all the intricate machinery of production and disposal. He is surprised and impressed by the perfection of the organization, how the work is divided and subdivided. He discerns the connection between chemical progress and human progress, and understands that Weldon's utilization of the waste liquors in the manufacture of chlorine made bleach cheaper, books cheaper, education cheaper. He grasps the idea of the tremendous importance of the chemical principle made a fact by the genius of the mechanical engineer and a thing of life by the skill and adroitness of the business man. And, when he ponders on all of these things he may see, more clearly than he has yet, the irresistible power that may be exercised by the human mind.

WONDERS AND ACHIEVEMENTS OF CHEMICAL SCIENCE.

In the study of organic chemistry the marvelous ingenuity of nature is illustrated in a way that is startling and impressive. With a few elements many thousands of substances are constructed, all differing in properties. The subtile ingenuity and inventiveness of nature manifested in this realm surpass in some ways anything found in other branches of science. Its wonderful atomic architecture, the infinity of kaleidoscopic changes of structure of which the compounds are capable, the astonishing and almost creative power that a knowledge of this science has given to man at first bewilders and then exhilarates the mind of the student. Its study cannot fail to assist the development of ingenuity, originality and independence of intellect.

Through organic chemistry the phenomena of life must be approached. The principles of development and degradation observed in living objects have been mostly studied as to external form and internal structure, and as yet little has been done to study the chemical relations and changes involved. The various species of a plant genus often produce compounds closely related. Substitution, isomerism, synthesis, analysis and atomic migration are all included in the growth of a plant. Who can say what wonders will be discovered when chemistry turns its search light on this field of silent activity?

It would take me too far from my theme to dilate on the advantages to be derived from a study of higher chemistry and its mathematical consideration. The student who studies chemistry as a liberal education can hardly expect to go as far as this, unless he can devote a post-graduate year or two to it. A year devoted to rounding up a course is always advisable when possible, but it is not always possible.

I cannot refrain from speaking of the value of a course of reading in the history of chemistry. It is hard to appreciate the enormous debt that our modern civilization owes to the development of chemical science, the discovery and application of chemical facts. In agriculture, manufacturing and medicine, in the increase of our personal comforts, in fostering health and resisting disease, in reducing the cost of living, in augmenting the thrift and happiness of communities,

in a better understanding of the failures and successes recorded in history, in the increasing ability to apply knowledge, in the development of a science of economies, in learning the relations between cause and effect and the accountability of matter to law, in an appreciation of personal responsibility—in all these things, and in others too numerous to mention, the influence of chemistry is clearly defined. The student cannot fail to understand how strongly and how beneficially a knowledge of chemistry will influence his own life—how much he will miss and how much he will discount his own activity if he has not a fair knowledge of it.

I am not now aiming to discuss the different studies of a chemical course, but to consider the characteristics of chemical study in general, and their effects on the student's mental development and character. The more detailed consideration of the work and study demanded in a chemical course would carry me far beyond the limits of a paper of this kind. It is evident, however, that all through life a man has to deal with the material objects about him; it may be to utilize them, to protect himself against them, or to appreciate their part in nature. It follows that he should have as thorough a knowledge as possible of the nature and properties of the matter of which these objects are composed. This knowledge cannot be obtained by mere attendance at lectures, no matter how well they may be experimentally illustrated, or by the reading of books. Experimental work with the typical forms of matter done by the student himself is demanded, and the acquisition of this direct knowledge powerfully and beneficially influences the student's mind and character, as I have endeavored to indicate. For these reasons I am convinced that a young man who does not intend to make chemistry his profession, but who expects to devote himself to mercantile pursuits, will find a course in chemistry, laid out on a broad basis of general education, the best preparation.—The Brooklyn Manufacturer.

BOOK PLATES OF CELEBRATED WOMEN.*

A DELIGHTFUL book has recently been published called "Ladies' Book Plates." In commenting upon it the St. James's Budget, to which we are indebted for the engravings and following notes, says: Unless we are much mistaken, Miss Norna Labouchere's most charming volume will do more to make book plates once again as fashionable as they were in the days of our great-grandfathers than either Lord de Tabley's "Guide," and the erudition of Mr. Egerton Castle, or the painstaking industry of Mr. W. J. Hardy. Miss Norna Labouchere has had the advantage of the active co-operation of experts like Miss Chamberlayne (who has devoted a lifetime to the study of "Ex-libris"), Mynherr Moes, of the Amsterdam Library, and Mr. Gerald Ponsonby, and she has brought to her self-imposed task a freshness of treatment and conciseness of style which must always fascinate her reader, where she is dealing with women bibliophiles, lady designers or feminine heraldry. Time was when one might say, "Show me her book plate, and I will describe its owner," and it really seems as if a great "Ex-libris" revival, common to both sexes, were likely to characterize the end of the present century and the commencement of its successor. For this probability enthusiastic workers, like Miss Labouchere, are mainly responsible. For four hundred years the fashion for "Ex-libris" has waxed and waned, but never has greater care been bestowed on their designs than in the present age, when the science can boast of possessing a journal of its own. It is impossible to praise too highly the beauty of Miss Labouchere's illustrations and reproductions, or the lucidity with which she handles a necessarily somewhat dry subject, until you lay down her dainty volume clad in apple green cloth as ardent an admirer of the once altogether neglected book plate as she is herself. For a frontispiece she has selected the ponderous and pompous "Ex-libris" of Henrietta Louisa Jeffreys, Countess of Pomfret, Lady of the Bedchamber to Queen Caroline, but just before the introduction comes the more modest "lozenge" of Eliza Godwin, followed three pages later by that of Mary Horner. Miss Labouchere tells us that the first woman's plate known in England is that of Elizabeth Pindar, in 1608, which bears the motto, "God's Providence is mine inheritance." Among her earliest reproductions, however, we have the "Ex-libris" of Dame Anna Margaretta Mason (1701), Dorothy Countess of Gainsborough (1707), and Rachel Duchess of Beaufort (1706). The annals of women bibliophiles appear to begin with Cleopatra and St. Brigetta, and they become particularly interesting when the writer describes the affection for books and book plates shown by Louis XV's daughters, Madame Adelaide, Madame Victoria, and Madame Sophie, who each possessed their own library, their own "Ex-libris," and their own distinctive color of binding. In modern Germany, where they are in almost universal use, the utmost care and attention is bestowed on the designing of book plates. That of the Empress Frederick (reproduced by Miss Labouchere) represents an angel bearing two shields; the dexter side is occupied by the arms of the Fatherland, while the sinister has England in the first and third quarters. For many other details of more than ordinary interest we must refer our readers to Miss Labouchere's elaborate essay, which will be as welcome in the drawing room as it will be in the library, and must henceforth be a necessity to the student of "Ex-libris" or the collector of past and present book plates. The clever writer, by some subtile power, contrives to captivate the general reader, and at the same time satisfies the requirements of the most exacting investigator of that little known branch of art which has been fortunate enough to find in her its latest and ablest exponent.

The delightful chapter which deals with mottoes on ladies' plates deserves as close attention as that on feminine heraldry. Lady Dorothy Nevill, it seems, protects herself from literary larceny by simply placing the words "Stolen from——" before her name; a German bibliophile contents herself with citing in bold type the text. "The ungodly borroweth and payeth not again;" but Miss Lena Milman, on the other hand, has adopted for a device the somewhat ambiguous phrase, "Come and take choice of all my library, and so beguile thy sorrow." Fortunately for the safety of her books, Miss Milman resides in the Tower of London. Another lady places on her "Ex-libris" the following lines:

"Oh for a booke and a shadie nooke,
Eyther in a-doore or out;
With the grene leaves whisp'ring overheade
Or the Streete Cryes all about,
Where I maie reade all at my ease
Both of the Newe and Olde;
For a jollie good Booke wherein to loke
Is better to me than Golde."

"Truth is the best thing that man may kepe" is the appropriate motto on Edith Goodman's plate, designed by a clever artist of the Birmingham school; and upon another equally picturesque "Ex-libris" of similar origin one reads the lines, "Without knowledge love is vain, without love knowledge is vain." It is to be hoped that Miss Labouchere's graphic descriptive powers will not be limited to book plates, concerning which she will henceforth be regarded as a standard authority. Appreciation of books has usually been so foreign to the feminine temperament that, if we may argue from the particular to the general, there is reason for congratulation in the thought that the present generation of women is becoming more bookish. An interest in book plates may at least be taken to suggest a preliminary love for books.

* "Ladies' Book Plates." An illustrated hand book for collectors and book-lovers. By Norna Labouchere. London: George Bell & Sons, York Street, Covent Garden; and New York. 1895.

Book-plate of the Duchesse de Berri.

Book-plate of Madame Victoire de France.

THE LIGHTING VALUE OF ACETYLENE.

PROFESSOR WEDDING recently delivered a lecture before the Verband Deutscher Elektrotechniker, in which he discussed at length the relative value of acetylene and coal gas. Dr. Wedding assumed from his experiments that a possibly very formidable rival to existing gas lighting had been born in the "practicable manufacture of acetylene from calcium carbide."

During the course of Dr. Wedding's discussion he stated that calcium carbide could be obtained at 3d. per lb. at present, but that he expected, when the production occurred on a large scale, that the present high price will be materially reduced. "If," said Dr. Wedding, "acetylene is to be used for street illumination, the object must be to enrich the coal gas whereever that exists. In experimenting in this direction we ascertain that without acetylene the burner had an effective consumption of 15 liters (1 liter = 0·035 c. f.), with 6 per cent. of acetylene it only requires 6 liters of the mixture of coal gas and acetylene, with 12 per cent. the consumption fell to 4 liters, and with 21 per cent. to 3 liters." Dr. Wedding then compared the cost of the most usual illuminants with the present price of gas, coal, petroleum, methylated spirit and calcium carbide in Berlin; a 16 c. p. lamp, according to various systems, would cost per hour:

Incandescent, gas	0·06 d.
Incandescent, spirit	0·144 to 0·3 d.
Petroleum	0·24 d.
Argand burner	0·30 d.
Electric glow lamp	0·36 d.

The Berlin prices assumed are gas 6s. per thousand c. f., methylated spirit 1s. 2d. to 2s. per gallon, petroleum 1s. 4d. per gallon.

As regards acetylene, its economy depends altogether upon the price of the acetylene which is to be mixed with the gas. Coal gas alone would require ½d. per hour for a 16 c. p. light, and an addition of acetylene up to 21 per cent. would steadily increase the lamps up to ¾d. If the price of acetylene falls, the cost of the light falls, especially with a slight admixture of acetylene. If the price of the cubic foot of acetylene should ever fall from the present figure of 5d. to ½d., the economy of the gas would increase with every addition of acetylene, although any additional admixture beyond 10 per cent. would have hardly any effect. If the acetylene is not burnt in the open, but in the regenerative burner, the price per 16 candle power would be 0·6d.—i. e., ten times as much as incandescent gas. Hence great reductions must yet take place before the latter can be competed with. We see, then, that the succession of economy is—incandescent spirit, petroleum, Argand burner, electric incandescent light, acetylene.—Progressive Age.

Book-plate of the German Empress.

Book-plate of Dorothy Countess of Gainsborough (1707).

Book-plate of the Baroness Burdett-Coutts (before her marriage).

THE State forestry commissioner estimates that the annual loss by forest fires in the State of Pennsylvania amounts to not less than $1,000,000. It is commonly supposed that a large proportion of the forest fires in this country are due to accident, but the commissioner, as the result of his investigations, reports that they "are always due to ignorance, carelessness or crime."

CIRCULATION IN WATER TUBE BOILERS.

WE present to our readers in this issue illustrations and a description of a series of exhaustive experiments which have recently been carried out at Messrs. Yarrow & Company's works, Poplar, England. The question of the circulation of water in water tube boilers is just now exciting a widespread interest, and in view of the proposed very extended use to which this comparatively novel class of boiler is to be put, any reliable data regarding their working, particularly in respect of the circulation of water within them, are of very great value.

An active discussion has recently taken place among the profession as to the actual course taken by the water in circulating through the tubes of this class of boiler. Messrs. Yarrow & Company point out that their experiments prove that the heating of the down tubes actually accelerates the circulation, and does not retard it, as is generally believed.

Before proceeding to a detailed description of the experiments, it is due to Messrs. Yarrow & Company that attention should be drawn to the generosity which prompted them to place before the world at large the results of their very costly and valuable experiments.

Experiment No. 1 is illustrated by Fig. 1. This model consists of two vertical glass tubes, attached to the bottom of a small tank, the tubes being united at their lower extremities by a copper bend. There are six Bunsen burners, three acting on each tube, and arranged so that they can be regulated at will. On the upper part of the model is a balance, the left arm of which is suitably loaded, and from the right arm is hung by a thread a grooved ebony bob, which is suspended in the down tube in such a manner that the water, when flowing downward, acting on the bob, causes it to descend, depressing the end of the balance to which it is attached. Fig. 1 illustrates the result when two lamps on the down tube are lit, in addition to the three acting on the up tube. This experiment does not indicate the speed of the current, but it shows very clearly any increase or decrease in the speed of the descending column of water, that is to say, the rapidity of the circulation.

When the pointer is vertical, it is at zero;

When it moves over toward the up tube side the figures are indicated as minus;

When it moves toward the down tube side the figures are indicated as plus.

The following are the results of carefully tried experiments:

When no heat was applied, the pointer indicated —45.

When only one lamp was acting on the up tube, the current was too intermittent to record a reliable result.

When two lamps were acting on the up tube, the pointer indicated —12.

When three lamps were acting on the up tube, the pointer indicated —5.

When three lamps were acting on the up tube and one on the down tube, the pointer indicated +10.

When three lamps were acting on the up tube and two on the down tube, the pointer indicated +15, as shown in Fig. 1.

When three lamps were acting on each side, the pointer indicated +20.

These experiments clearly prove that the circulation gradually increased as more and more heat was applied, irrespective of the proportion of the total heat absorbed by the up and by the down tube. Further experiments showed that, within certain limits, the rapidity of the circulation depended solely upon the total amount of heat applied, irrespective of how this heat was divided between the descending and ascending columns.

Experiment No. 2.—In this experiment the grooved ebony bob in the down tube was replaced by a small screw propeller, which, when revolving, actuated a vertical spindle, having at its upper end a worm, gearing into a small worm wheel, as will be seen. This arrangement was made at the suggestion of Mr. Maxim, and it enabled the speed of the current, under varying conditions, to be estimated.

When two lamps were acting on the up tube, the speed recorded by the propeller was found to be 28 feet per minute.

When three lamps were acting on the up tube, the speed was 36 feet per minute.

When three lamps were acting on the up tube and one on the down tube, the speed was found to be 42 feet per minute.

When three lamps were acting on the up tube and two on the down tube, the speed was 49 feet per minute.

When three lamps were acting on the up tube and three on the down tube, the speed was 55 feet per minute.

These experiments confirm those previously described with the suspended bob, proving a gradual increase of speed in the circulating system as more and more heat was applied, irrespective of whether this heat was absorbed by the water in the up tube or by the water in the down tube. It should be remembered that, owing to the resistance offered to the flow of water by the screw, the actual speeds, if no screw had been there, would have been greater than those above recorded. In addition to this, an allowance must be made for the slip of the screw.

It must be borne in mind that in all the foregoing experiments circulation must have been set up by heat being first applied to the up current, which in all water tube boilers is the case, those tubes nearest the fire being heated first, and thus circulation is established.

These experiments also illustrated what has not yet, we believe, been referred to, viz., that any bubbles of steam formed in a descending column rapidly disappear; and it is more than probable that in a down tube moderately heated no steam whatever is formed, because as the current descends the temperature of the water can rise without producing steam, owing to the increased head of water and the higher temperature of the boiling point at the greater pressure. For example: Under atmospheric pressure the water in the upper part of a tube would boil at 212°; but the water in the lower part of the tube, if four feet long, would boil at 218½°; consequently, the whole body of water can be raised from 212° to 218½° while descending without producing any steam. This heat thus absorbed is given off by the conversion of a portion of the water into steam as the current ascends in the up tube. In the experiment the bubbles could be clearly seen forming where the flames impinged, and as they descended to disappear, the steam parting with its heat and raising the temperature of the surrounding water.

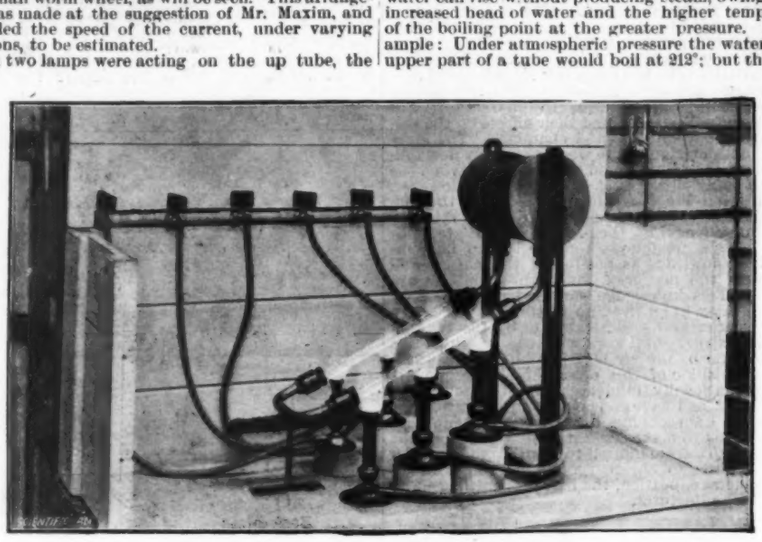


FIG. 2.

Experiment 3, shown in Fig. 2, was illustrated by a model consisting of two glass tubes, placed at a small angle to the horizontal, their upper ends being connected to a small cistern and their lower ends united. The tube on one side was arranged to be heated by three Bunsen flames and the other tube also by three Bunsen flames of smaller size. When once the circulation was started in the up tube by the three larger flames, those acting on the down tube could also be lit and the circulation could be clearly seen to be accelerated.

Experiment 4 consisted of a cistern from the bottom of which were led three tubes, the lower portions of which were of copper and the upper portions of glass. The three copper tubes were united at their lower extremities, being secured to a horizontal chamber. They were all situated in a gas furnace, lined with asbestos, heat being applied directly to the tube on the one side by means of several multiple Bunsen burners, the flames from which passed across the other two tubes and up

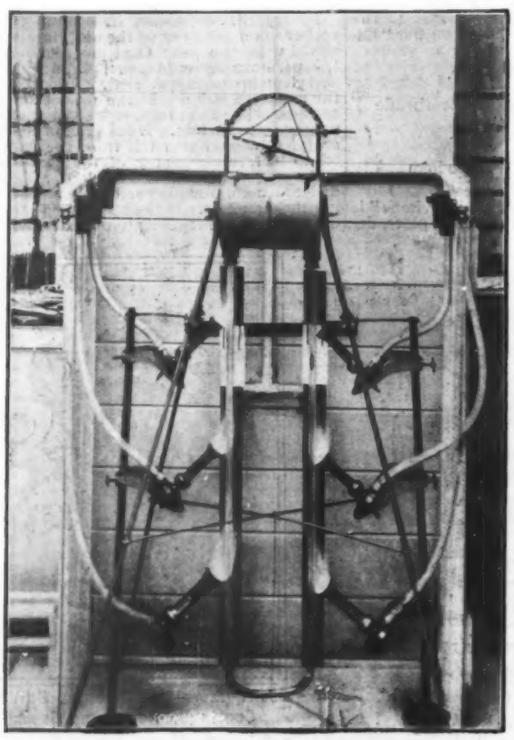


FIG. 1.

FIG. 3.

the funnel which is seen in the photograph. This experiment more nearly approaches the conditions of an ordinary Yarrow water tube boiler, and it was seen that sometimes there were two down currents in the two cooler tubes, and one up current in the tube most heated, and at other times there were two up tubes and one down tube. In this model as much as 9 lb. of water per square foot of heating surface was evaporated.

Experiment 5 consisted of two glass tubes projecting from a small tank, the tubes being nearly vertical. These glass tubes were united to copper tubes. At the bottom of these was a T-piece, to which a third tube of copper was connected, the upper extremity of which was secured to the bottom of the tank.

The two composite glass and copper tubes were in front and the copper tube was at the back, this latter representing an outside down pipe. Multiple Bunsen burners were provided for heating all three tubes. On heating the two front tubes an up current was established in both, the copper tube at the back serving as an outside down pipe, and the speed of the current could be seen by watching the flow of water and steam in the glass tubes. When heat was applied to the down comer at the back, it was clearly evident that the circulation was accelerated.

Experiment 6, shown in Fig. 3, consisted of a small tank from which were led two inclined glass tubes, united at their lower extremities. Provision was made to introduce a current of air from an air tank under pressure into either or both these tubes, as will be seen. When upward circulation had been established in the one tube, by introducing bubbles of air, then a further supply of air was admitted into the down tube which air passed downward with the water and then upward in the up current, increasing the circulation, which was maintained even after the supply of air had been completely cut off from the tube containing the ascending column, the circulation continuing in the same direction, air only being admitted into the down tube.

All the foregoing experiments were made at atmospheric pressure.

Experiment 7, shown in Fig. 4, illustrated the action under a pressure of 150 lb. per square inch. It will be seen that at the upper part of the model is a steam chest, to the bottom of which was attached a U-tube, fitted with glass at its upper extremities, so as to render the circulation visible. There were three small Bunsen lamps in connection with the one leg and five large Bunsen lamps in connection with other leg. It was found that, if the circulation was once established by lighting the three small Bunsen flames on the one side, producing an up current on that side, then the five large flames on the down current might be started, increasing the circulation, which actually continued after the three flames in the up tube were all turned out. This extreme condition under which circulation can be maintained, we venture to say, is one which few engineers would believe possible, and confirms the views expressed by Prof. Lambert and Mr. Maxim.

Experiment 8 was made on a full size section of a water tubes boiler of the Yarrow type, with straight tubes, working at a high pressure. At one end there was a furnace under forced draught by means of a jet in the funnel. The flame passed transversely across the group of tubes to the funnel, situated at the end opposite to the furnace. In the tube furthest removed from the furnace was placed a small screw propeller, and also a similar fitting in the third tube from the end, by which the direction of the current and its minimum speed could be estimated. On raising steam and forcing the fire the propellers were seen to revolve in a direction indicating a steady down current in either one or both of the tubes in which the propellers were introduced, previous experiments proving that a down current existed in the second tube from the end. It was found that there were never less than two down tubes in operation.

Experiment 9, shown in Fig. 5, represented also a full size section of a Yarrow water tube boiler having straight tubes, heated in the same manner as in the former case. The circulation was rendered visible by the upper part of the tubes being of glass. It could be clearly seen that an upward current was established in those tubes nearest the fire, water descending in those which were furthest removed from it, confirming the previous experiment.

It may here be remarked that the maximum evaporation obtained by Messrs. Yarrow & Company, when the circulation has been forced to a very high pitch, was 25 lb. of water per square foot of heating surface, but this being an uneconomical amount of forcing, is far beyond the range of what is desirable in practice.

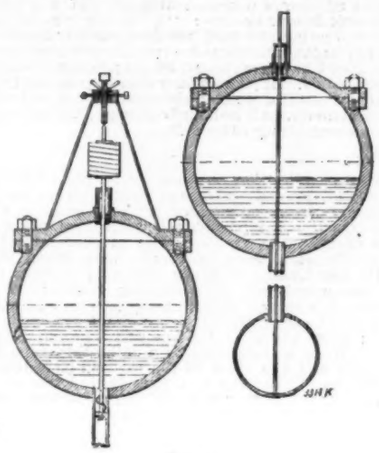


FIG. 6.

Experiment No. 7 clearly proved that circulation was more efficiently maintained at a high than at a low pressure, it being found that the extreme condition of maintaining circulation by applying heat only to the down pipe was never certain, except with pressures over 50 lb. per square inch; between 30 lb. and 50 lb. this result was doubtful, and below 30 lb. it was not possible.

The reason of this is probably due to the reduced velocity of the down current in the case of low pressures, owing to the greater bulk of a given weight of steam at low than at high pressures, all of which steam has to pass through the up tube, or, in other words, there is less resistance to a given weight of water and steam at a high pressure flowing through a system of tubes than at a low pressure, on account of the lesser bulk of the water and steam in the former case.

The exact arrangement of the propellers in connection with No. 8 experiment is clearly seen by the sketch showing a section through the steam chest and one of the tubes containing the propellers.

In order to obtain reliable data as regards the temperature of the tubes, which are exposed to the fiercest action of the fire, the following facts in connection with No. 8 experiment will be instructive, and to fully explain, reference must be made to the section through the tube nearest the fire.

The lower end of a long rod was attached to the water chamber at the bottom, this rod passing up through the center of the tube and thence through the top of the steam chest. At the upper end of this rod was a pointer and a similar pointer was affixed to the steam chest itself, the two pointers being exactly in a line with one another. Thus, whatever difference in the relative lengths of the tube and the rod took place, it would be at once made evident by alterations in the position of the pointers in relation to one another. If thus the tube, owing to its being exposed to great heat, expanded more than the rod, it could at once be detected, and any such increased relative length would be an indication of an increased relative temperature.

Now it was found that there was no visible difference in position between the two pointers, whether the fire was forced or extinguished, and as the rod passing up through the steam and water would have a temperature equal to that of the steam and water, it follows that the temperature of the tube is the same, or the difference, if any, is so trifling as not to be indicated by the means above described.

This experiment conclusively proves that, so long as there is good circulation, no possible objection can exist to the adoption of straight tubes, as in a Yarrow boiler, owing to any imagined necessity to allow for variations in length, due to differences of temperature. For all practical purposes, the temperature of all the tubes may be considered the same as that of the water they contain, in the same manner as in an ordinary marine or locomotive boiler, in which no special provision is made for differences in expansion of the tubes, although they are by no means all exposed to the same extent to the action of the heated gases. This experiment, which is confirmed by practical experience in the use of the Yarrow boiler, points conclusively to the fact that the curving of tubes in water tube boilers (having good circulation) for the sake of allowing for variations in length due to variation of temperature is quite unnecessary.

PROSPECTS OF USING OIL AS FUEL.

RAILROAD officers are frequently importuned by inventors of oil-burning appliances to adopt their devices and burn oil in locomotive fireboxes, great claims of saving being made. There are circumstances under which liquid fuel is cheaper than coal, but they are very rare. At the last meeting of the American Society of Mechanical Engineers the subject was discussed with a result that brings no comfort to the oil advocates. The question was submitted, Are there any conditions under which oil fuel is cheaper than coal for generating steam at points on the Atlantic seaboard?

The answers given to this question were to the effect that if a man owned an oil well and a coal mine, the oil would be the cheaper fuel; but, under existing conditions, the companies controlling the oil wells keep the price of oil so high that coal is the cheaper fuel. There is no difficulty in using oil fuel in a locomotive, but the supply is not nearly equal to provide fuel for one-tenth the locomotives running in this country. In fact, it is estimated that the locomotives in use on the Pennsylvania Railroad alone would use half the oil production of this continent if they were all burning oil.—Locomotive Engineering.

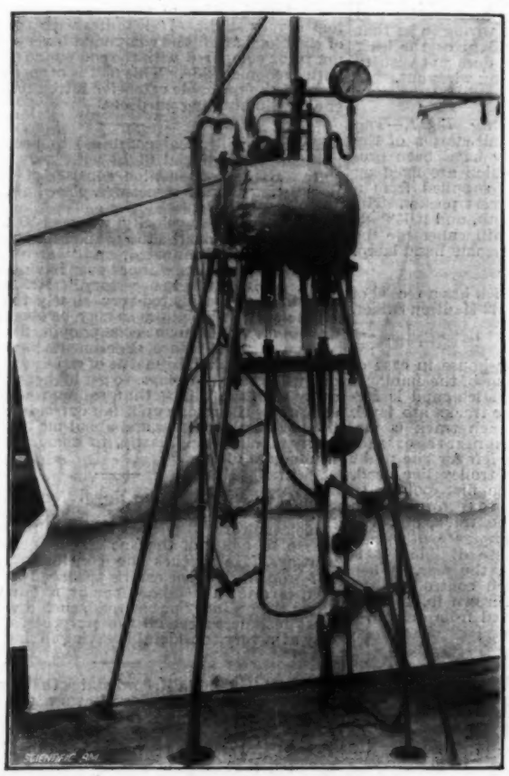


FIG. 4.

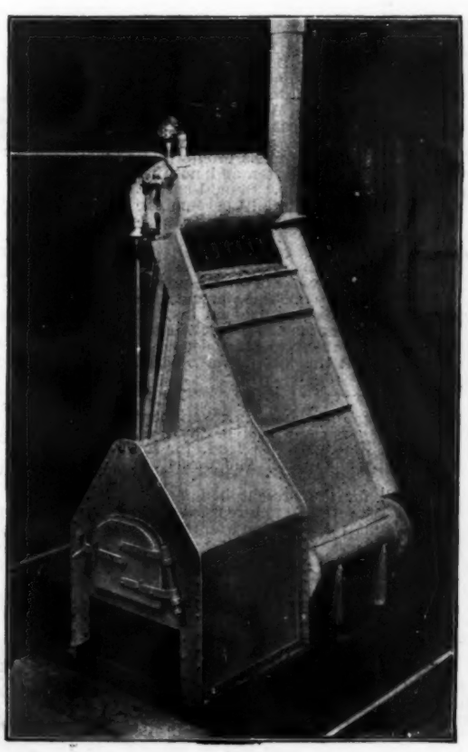


FIG. 5.

ENGINEERING NOTES.

THE Glasgow subway, which is nearing completion, consists of two independent circuits of about six and a half miles circumference. The cars are to be run in pairs at a speed of 15 miles per hour, the weight of the two cars together being 24 tons. Each cable will be in one piece and will weigh 60 tons.

The American Manufacturer estimates the total domestic pig iron production for the year 1895 at 9,372,042 tons. This is estimating that the production of December will be 950,000 tons, or about what it was in November, when the production was 934,449 gross tons. This indicates that production of pig iron in 1895 was the largest in the history of the country, the nearest approach to it being in 1890, when the production was 9,202,703 tons. That is, the production in 1895 has increased day by day until at the close of the year it is nearly a million tons a month. As compared with 1894, there was an increased production in 1895 of 2,730,251 tons, or 41 per cent. The same journal says that unless Great Britain shall greatly exceed any previous year's production, this is the largest year's production of pig iron in any country in the world.

The Smoke Nuisance in Chicago.—In reporting on this subject for the past year in Chicago, Ill., Inspector May estimates that 100,000,000 gallons of water are converted into steam daily in that city, requiring the burning of 50,000,000 pounds of bituminous coal from the Illinois and Indiana mines, 90 per cent. of which is consumed in the daytime. Mr. May thinks that the apparent failure of good smoke-consuming devices, of which there are very few on the market, is due to the fact that the majority of steam producers in Chicago expect from their plants a duty of from 40 to 75 per cent. in excess of their rated capacity, necessitating heavy firing. The use of high grade coal or coke is suggested for tugboats and locomotives, as no device is known which will keep soft coal from smoking when used for these purposes, although for stationary boilers the department is satisfied that smoke can be prevented without reducing the maximum capacity of boilers.—Engineering Record.

Pittsburg has passed an anti-smoke ordinance, according to which an emission of 20 per cent. of black or gray smoke from any boiler stack for more than three minutes at a time is punishable by a fine ranging from $10 to $50.

A movement is in progress, in the United States, having for its object the development of a system of mechanical engineering "experiment stations," on much the same basis as the existing agricultural experiment stations. It is anticipated that the outcome will be the organization of such stations in all the agricultural and mechanical colleges of the country in which the agricultural experiment stations have been successfully organized and operated. The purpose of the movement is to secure the promotion of engineering research, and of the development of the scientific facts and principles which are of most value to the mechanical arts and to the profession of engineering. The headquarters of the central office, to which all will report, is thought likely to be the Bureau of Steam Engineering of the Navy Department; that being the largest, most important, and most generally suitable of the government bureaus to take cognizance of such work as is contemplated. A department of mechanical arts was proposed years ago, probably earlier than the Department of Agriculture; but the importance of the former has not been as promptly or as fully recognized as that of the latter, and nothing has yet been done in that direction. Should such a department be founded, it will naturally become the center of the work of mechanical engineering experiment stations.—Nature.

The Japanese appreciate the value of naval power, and the necessity for ample dry dock accommodation if such power is not to be seriously hampered in time of war. Their new dry dock at the naval port of Kure is to be 464 feet long, 69 feet wide, and 42 feet deep; dimensions which would admit the docking of a 15,000 ton battle ship.

According to press reports, the same government has made arrangements with the firm of Sir W. G. Armstrong & Company, Newcastle, England, for the erection of a steel foundry in Japan. The terms are as follows:

1. The material shall for the present be imported from England. 2. Of the workmen to be employed, 20 per cent. shall be brought from England and 80 per cent. shall be Japanese. 3. When a new arm is invented in England, it shall be manufactured at the works in Japan. 4. For a stated number of years the Japanese government shall give a fixed subsidy to the company. 5. On the expiration of the period during which the company receives a subsidy the works shall be sold to the Japanese government.

The French first-class cruiser provided for in the naval programme of 1896 is specially interesting, since she may be regarded as an answer to the English first-class cruisers Powerful and Terrible. She will displace 10,825 tons (11,000 metric tons) and be 469 feet 2 inches long, with 63 feet 8 inches beam, and will have a draught of 26 feet 7 inches aft. Much care is to be given to the matter of protection. The armament will consist of two guns of 7·63 inches, eight quick firers of 5·5 inches, 12 of 3·9 inches, 16 of 1·85 inches, eight of 1·45 inches, and two Maxim machine guns, besides two submerged torpedo tubes. Engines of 28,000 maximum horse power, driving three screws, are to give a speed of 23 knots. The normal coal supply of 1,400 tons will give a range of 10,000 miles at ten knots and 1,200 miles at full speed, but these distances may be extended to 15,000 and 1,800 miles respectively with an added supply of 1,300 tons of coal. The cruiser's complement will be 48 officers and 578 men.

ELECTRICAL NOTES.

THE direct production of electricity is discussed by Dr. Louis Duncan in Cassier's Magazine. He adopts Prof. Borchers' definition of the problem as being that of "the conversion of the energy of fuel (including fuel gases) into electrical energy by oxidation, without transforming the energy into heat and without the destruction of the chemical reagents or the formation of waste products that require regeneration." There are a number of batteries which oxidize the carbon, but the oxygen is taken from the electrolyte, and not from the air. The solution of the problem depends upon the discovery of a proper electrolyte, and it will probably be effected with a solid fuel. Dr. Duncan has tested a number of patented methods, and as a result of his experiments he says: "Up to the present time I know of no method that has been publicly described that fulfills the conditions or gives any promise of success. But I have seen a method not patented yet, and, unfortunately, not mine, which does apparently fulfill the conditions and which gives currents, not measured in milliamperes, as is ordinarily the case, but in honest amperes and plenty of them."

Funeral Trolley Cars.—According to Invention, one of the quaintest adaptations of electricity, or, rather, electrical appliances, has recently been made in Chicago. On the line of the electric street railway company of that metropolis is the great cemetery of Oakwood. Heretofore, funerals have taken place in the usual manner by the means of hearses and the accompaniment of mourning coaches. Now, however, the enterprising tramway company is building funeral cars. These above the tracks will be black; even the trolley poles will be wound with crape. When the deceased is a child, this crape will be white and the sides of the car will be festooned with white. Inside the car, just behind the motorman, a bier will occupy one side. Opposite this are to be seats for the minister and pall bearers. The mourners will sit along the sides of the car. Funeral parties may charter a train with any number of cars, which will start from any point on the line. A special motorman and conductor will be uniformed in black.

Domestic Electric Lighting.—On the subject of house wiring, says the London Electrician, the consumer no doubt has his opinions, inarticulate at present, probably illogical, but possibly worthy of some consideration. One of the many merits of iron barrel and of concentric wiring is that they are calculated to remind the consumer of the familiar gas pipe. The external resemblance between the early railway carriage and the old stage coach induced many a timid conservative to adopt the new mode of locomotion, and if the householder finds that, in lieu of a maze of mysterious looking wires in ugly wooden troughs, something bearing a striking resemblance to his old familiar friend, the gas pipe, is all that an installation of the electric light need involve, he may come to regard the adoption of the new mode of illumination less as a bold departure and more as an inevitable matter of course. Apart from the aforesaid graver considerations of safety, the average householder will probably consider the best form of wiring to be that which looks simple, costs little and gives the least trouble. He, at any rate, poor man, does not wish to be forever drawing wires in or drawing wires out.

Railway Officials and the Electric Light.—The ticket-collecting staff at the Vauxhall station of the London and Southwestern Railway have been provided with small electric lamps, which are fixed on their overcoats, the current being supplied from a miniature battery carried in the breast pocket. The experiment is to be tried for a month, and if it finds favor with the officials electricity will supersede the old fashioned and somewhat cumbersome hand lamp.

An incandescent electric lamp which has a record of 19,000 hours is being exhibited at 242 Madison Street, Chicago.

A new method of emptying a car house in case of fire has recently been patented by one of the employes of the Detroit Railway, of Detroit, Mich., and is certainly ingenious in conception. The tracks are level, but the trolley wire running over each track is furnished with a cut-out switch, located near the exterior of the building. When the cars are left for the night this switch is opened, leaving the trolley line dead, and each controller is put on the first point. In case of fire an employe has simply to turn the switch operating the trolley line over the track, and the cars immediately file out at a slow rate of speed. In case the motors on one car are disabled, it is pushed by the one immediately in the rear. When these cars are safely out, the switch controlling the trolley line over another track is thrown in, and the cars on that track are safely removed from danger.—Street Railway Journal.

An expense of operation of 22 cents per mile is claimed for the Metropolitan Elevated Road of Chicago. It is expected to open the Douglas Park extension early in the spring.

Bottle Labeling Machine.—One great difficulty in designing machines for labeling bottles is to devise a mechanism that will detach the top label from a pile, so that it may be subjected to the action of a paste roller, and afterward pressed against the bottle. The Western Electrician contains a description and illustration of a machine in which this is effected by a solenoid and core worked by a dynamo, the plunger attached to the core being charged statically by an ordinary glass friction machine. It is found, as might be expected, that the regulation of the slight impulse of static electricity required to attract the top label is a matter of considerable delicacy. The machine is the property of Mr. J. F. Small, of Chicago, one of the inventors.—The Electrical Engineer.

MISCELLANEOUS NOTES.

THERE is an oil well in the Sabutschine region of the Transcaucasus whose daily yield is 820 tons of petroleum; and another well has yielded during a flow of fourteen hours, 13,120 tons. Since last May the daily yield of the latter well has been 3,280 tons of pure petroleum.

The Aluminum Corset.—Dr. Phelps, of New York City, recently addressed the Academy of Medicine on the merits of the various materials used in spinal disease. In lateral curvature, the jacket of aluminum was, so far as he had tested it, freer from objections than the others, but it was somewhat expensive, costing fifty dollars or more. A plaster corset was first made, the patient being suspended; this was filled with plaster, and over the latter the aluminum corset was hammered into shape. It had numerous perforations smaller than a dime. The weight of the apparatus is about two pounds. If the patient changed much in shape and size, it would be necessary to make a new corset.—Medical Review.

Russia already ranks as sixth among the wine producing countries of the world, and will probably soon surpass Germany in this respect. In the province of Bessarabia alone there are 216,000 acres under vines, or nearly half the arable land.

Large Dry Dock.—It is said that the new dry dock which is soon to be built in New York City will be the largest floating in the world. New sections will be added to it from time to time, and it is proposed to make it capable of receiving the largest ships that enter the harbor. The construction will be of wood and iron. There will be seven sections, each of which will have the following dimensions: Length over all, 66 feet 6 inches; beam, moulded, 116 feet 10 inches; inside width, 100 feet; depth at midships, 12 feet 11 inches. The total length of the dock will be about 500 feet. The sections will be so constructed as to be connected or disconnected at will. Electricity will be used to drive the centrifugal pumps. The cost of the dock will be about $300,000, and the time for constructing will be about nine months. The dry docks at present in use in this harbor are incapable of accommodating the largest ships. The syndicate which controls them has raised the rate paid by ship owners from ten cents per registered ton for the first day and eight cents per registered ton for the succeeding days of the vessel's stay in the dock to sixteen cents per registered ton for all days, excepting holidays. It is said that the new company's rates will be much lower than those of the syndicate. The location of the new dock will probably be at Erie Basin.

It is announced that Dr. Behring has discovered an anti-cholera serum, and that at an early date he will make a public demonstration of its properties.

According to Science, recent experiments by Grehaut show that the effect of acetylene upon the animal system is very slight. If it unites with the hæmoglobin of the blood at all, the compound is very unstable, and not to be compared with the compound of hæmoglobin with carbonic oxide. This fact is of special interest in view of the probable extensive introduction of acetylene for illuminating purposes.

Mr. Otto Lilienthal continues to prosecute his experiments on artificial flight with very promising results. His latest machine consists of two superimposed wing-shaped structures, placed about 7 or 8 feet apart.

In a wind whose velocity was over 30 feet a second, he was raised from the top of the hill, on which his experiments are conducted, and "carried in a nearly horizontal direction, without even having to run at the start, as is generally necessary." Mr. Lilienthal has evidently approximated very closely to the sailing of birds; such for instance as may be observed from the deck of a steamer in an accompanying flock of seagulls.

Regarding his future experiments he says: "I have made up my mind, by means of either a stronger wind or by flapping the wings, to get higher up and further away from the hill, so that sailing round in circles, I can follow the strong uplifting currents, and have sufficient air space under and about me to complete with safety a circle, and, lastly, to come up against the wind again to land."

In the Journal of the Royal Agricultural Society Mr. F. S. Courtney discusses the use of self-propelling vehicles in rural districts, where the population is too sparse to admit of the successful operation of light railways. He reaches the conclusion that: "If a self-propelled vehicle can be produced at a reasonable cost, carrying a moderate load at a fair rate of speed along the ordinary public road, such a vehicle must in most instances meet all the purposes of a light railway at a very considerable saving in first cost."

The Philadelphia Record states that a most remarkable electrical storm occurred at sea early in December last, off the Grand Banks of Newfoundland, and the effects were experienced by the British steamship Mercedes, which was carrying a cargo of iron ore. It is stated that on the nights of December 3d and 4th the ocean appeared like a mighty mass of flames or an endless stretch of prairie fires. Balls of electric fire hissed and exploded in all directions and darted among the vessel's masts and rigging. A heavy gale from the southwest sprung up, accompanied with high seas, during which the ship was badly damaged. When the storm had partially subsided, the electric fire appeared in all directions. It hung in big balls for two nights from the masts and fore and aft stays and practically turned night into day. As the fire balls came together they would burst with a loud report upon the vessel and disappear. Under the light at night such temporary repairs were made as were deemed necessary to reach port.

THE VALUE OF SOCIAL STATISTICS.

MR. CARROLL D. WRIGHT, United States Commissioner of Labor, recently delivered the third lecture in the special course on the Science of Social Statistics at the School of Social Economics, 34 Union Square, New York, taking for his subject the question of the true value of social statistics relating to births, deaths, marriages, divorces, crime, pauperism, etc.

The statistics of births, deaths and marriages are very defective, there being but few States having registration boards, and even in some of these the laws are not well enforced. This being true, the death rate given in cities is, in many respects, very misleading. The faults of enumeration, taken in connection with the faults of registration of births and deaths, lead to many erroneous conclusions as to the birth rate and the death rate. It is true that in a census year the death rate is calculated with an approach to accuracy because of the recent date of the enumeration of population; but in subsequent years the death rate is ascertained by estimating the actual number of deaths proportionately to the estimated population. Dr. John S. Billings, the most eminent authority in this country on vital statistics, says the federal census does not secure more than 60 or 70 per cent. of the deaths; and Mr. Wright has also found that in States where the law requires returns of marriages they are oftentimes at least 10 per cent. out of the way.

CONJUGAL CONDITION IN THE UNITED STATES OF ALL PERSONS 20 YEARS OF AGE AND OVER.

	Total number.		Per cent.
Single	8,670,243	or	25·64
Married	21,999,261	"	65·04
Widowed	2,965,053	"	8 77
Divorced	119,854	"	0·35
Unknown	68,076	"	0 20

According to the census federal figures, of the number of persons 15 years of age and over in the United States in 1890, 36·87 per cent. were single and 7 65 per per cent. widowed or divorced. Considering this fact relatively to nativity, it is found that 66 96 per cent. of all persons 20 years of age and over of the native white population having native parents were married, and that 53·68 per cent. of the native white population having foreign parents were married. Of the white population of foreign birth, 66·89 per cent. were married.

The increase of late years in the number of divorces is not due to more liberal divorce laws; for the highest percentage of divorces is found in Illinois; whereas there are other States where divorce can be more readily obtained. Nor can it be urged that parties seeking divorce move temporarily to those States that possess liberal laws; for statistics show that the greater part of the divorces take place in the same State as the marriages.

Percentage of population 16 years of age and over unmarried in various countries: In France, 33 per cent.; in England and Wales, 37 per cent.; in Italy, 37 per cent.; in Germany, 42 per cent.; in Belgium, nearly 45 per cent.; in Norway and Sweden, 40 per cent.; in Portugal, 43 per cent.; in Switzerland, 44 per cent.; and in Ireland, 42 per cent.

The statistics of crime, pauperism, and insanity are beset with many difficulties, and often lead to many false conclusions when comparisons are attempted, for the reason that more recent statistics are more nearly perfect than those of a decade or generation ago. Consequently the effort to compare imperfect with perfect or nearly perfect statistics results in a very wide variation from the truth.

The difficulties are increased when criminal conditions are attempted. The rigid or lax execution of the law results in an increase or decrease of the number of criminals. In a given municipality, under one administration arrests under a certain class of laws, like those relating to drunkenness, may be insisted upon, while at another time, under another administration, there may be a laxity in this direction. The comparison of criminal statistics, therefore, in the same city for different periods leads to widely varying conclusions, and when the comparison is made between different cities, the difficulties increase.

So relative to States, the difference in laws and the manner of executing criminal laws disturb and distort all criminal statistics. One instance of this will suffice. A certain State has in its criminal code over 150 offenses defined as crimes and punishable as such; while another State has about 100 offenses so described and punishable.

To compare the criminal statistics of these two States is simply criminal in itself; especially as the punishment for the same crime varies as widely as the number of crimes. One State punishes adultery with imprisonment in the State penitentiary, while in another State adultery is punished by a fine of $20. All these disturbing elements make a reliable comparison of criminal statistics quite impossible.

As an interesting example of this the lecturer gave some statistics of the Commonwealth of Massachusetts, where such statistics from 1860 to 1879, inclusive, a period of twenty years, were very perfect. They show that during that period the total number of sentences for all kinds and classes of crimes arose from 16,513 to 23,149, being an increase of 70·4 per cent., while the increase of population was but 50·4 per cent. There had been a very great decrease in the last year, but in 1873 the number of sentences amounted to 46,684, the increase over 1860 being 144 per cent., while the increase of population was but 34 per cent. This would show a remarkable increase in crime in the staid Commonwealth of Massachusetts; but analysis shows that 60 per cent. of all the sentences during that whole twenty years were for what might be denominated "rum offenses," a class of crimes brought into existence, so far as classification is concerned, by legislative enactment. For all crimes other than for drunkenness and like offenses during the same period, there was but 20 per cent. increase as against 50·4 per cent. increase of population.

Taking the high crimes, those that really constitute the volume of crime in a community, the increase was 39·5 per cent., while the population increased 50·4 as stated. Sixty per cent. of the sentences during the twenty years named was the result of legislation; and the new crimes added by the law should be eliminated when comparisons are made, and only those crimes that existed at a previous period brought into comparison at the later period. Civilization has raised many things formerly considered as offenses against the moral law into well defined crimes. The result is that we are constantly increasing the work of the criminal courts; and the number of sentences has positively increased, even when the volume of crime may have been decreased.

What is true of the danger of making statistical comparisons between cities and States holds true also when such comparisons are instituted between nations.

In France there were in prison per each 1,000,000 inhabitants:

From 1831—1840 an average No. of	51[illegible]	persons.	
" 1841—1860	"	515	"
" 1871—1880	"	489	"
" 1883—1887	"	352	"

In the United States there were in prison per each 1,000,000 inhabitants:

In the year 1850—	6,737	persons or 290	per each 1,000,000
" 1860—19,086	"	607	"
" 1870—32,901	"	853	"
" 1880—58,609	"	1,169	"
" 1890—82,329	"	1,314	"

The number of imprisonments in France is no doubt largely modified by the repressive effects of the police system, which is in many respects the best in the world. In considering the figures for this country, it must be borne in mind that during these years much of the United States territory was experiencing all the wildness of "border life;" and that to-day there are some more remote districts where the vigilance committee is not even yet a thing of the past.

The raising of the standard of the criminal code in the United States generally has, no doubt, increased the number of convictions as before explained; and the increased ratio of imprisonments cannot be taken as indicating a proportionate relative increase in crime.

THE GRAPHICS OF PIANO TOUCH.

MUCH trouble has been taken in order to construct an apparatus that will reproduce graphically the effects of touch in keyed musical instruments. The ex-

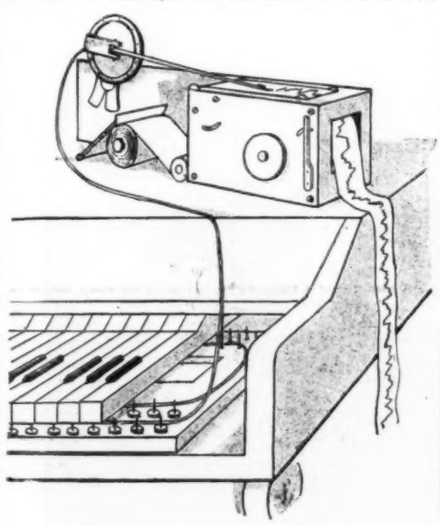


FIG. 1.—Illustration of the Apparatus.

periments are most easily made with the piano, and have therefore been tried on that instrument.

Recently a most interesting article appeared in the Revue Scientifique, written by MM. Binet and Courtier, who have studied this subject closely, and have made many experiments with their apparatus. They have treated the matter very fully in their article, of which the following is a résumé:

When a certain point of perfection has been attained in piano playing, it becomes very hard to distinguish inequality of touch, yet, owing to the varying strength of the fingers, it is only with much practice that perfect equality is possible. As will be seen further on, involuntary movements and irregularities, scarcely perceptible to the ear, are shown by the graphical method.

The apparatus (Fig. 1) is quite simple in construction, and consists chiefly of an India rubber tube, placed under the key board, united at its two extremities by a registering drum, also of India rubber. When the notes of the piano are played, the pressure on the tube causes a wave of air to be sent through it into the drum, upon which is attached a pen that in the ordinary way is made to record its movement on a moving roll of paper. The wave makes the drum vibrate, which in its turn jerks the pen, thus causing irregular marks to be left on the paper. The board on which the tube rests is regulated by means of wedges adjusted by a screw, the board being either lowered or raised. When raised it almost reaches the notes of the piano, and in this case the registering action takes place; but if it is lowered, the whole apparatus is disconnected from the key board.

When no notes are being played, and the registering drum is connected, i. e., the board is raised, merely a straight line is drawn. In Fig. 2, first a is struck, then two notes with b, then three notes with c, and

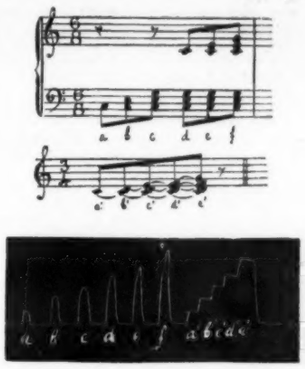


FIG. 2.—Effects produced: a, in striking one note, and b, c, d, e, f, in striking chords of two up to six notes; in the second case, a', b', c', d', e', in playing five successive notes, and keeping them down.

so on. It is difficult to tell whether the mark made for each additional note is the same length, for when three notes are struck they may not each be struck with the same force. In the second case (Fig. 2) one note is struck, held down and another struck, and so on, the previous notes always being kept down. The effect produced is curiously like a flight of stairs, but the height of each stair is not absolutely equal. This proves that the apparatus is sufficiently sensitive to show, by the height of the lines, the intensity with which a note is struck.

With regard to time, it is reproduced with the utmost precision, and it is in order to guarantee accuracy that the tube is connected to the drum at both ends, otherwise the notes situated near the end which was not connected would be further removed from the drum than the others, and this would cause a delay in their being registered.

The graphical form ought theoretically to be an im-

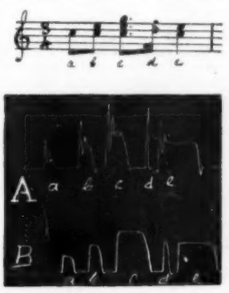


FIG. 3.—A represents effect without the insertion of the diaphragm, B the effect with the diaphragm.

itation of the movement played, but this result is not often achieved. When very quick passages are being played, the strong wave of air shakes the drum so forcibly that the pen ceases to act properly. Much trouble has been taken to devise a way of lessening the force of the wave; among other materials, cotton has been inserted into the tube, but these experiments were not entirely successful. It has been found that placing a diaphragm with a small hole in the tube lessens the force of the wave of air very considerably, and to a certain extent prevents the drum vibrating too strongly.

The effect produced without and with the diaphragm will be seen in Fig. 3.

Figs. 4 and 5 illustrate shakes, and show clearly the importance of equality of touch; they show, too,

FIG. 4.—Shake executed with first and second fingers.

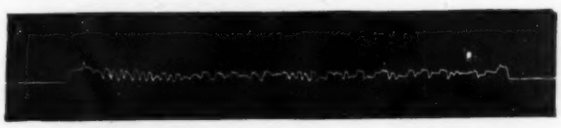


FIG. 5.—Effects produced by an irregular shake.

how precisely the apparatus reproduces any irregularity.

Many questions have to be considered with regard to quick playing, but one of the most striking features is that the more quickly the notes are played, the more the force of the movement diminishes, until finally a certain stage is reached when the amplitude ceases to vary.

Let us now consider the advantages of the instrument. They are threefold.

(1) Dealing with its advantage from the psychologi-

cal point of view, it is found that the voluntary movements of the pianist can be observed without putting him to any restraint or embarrassment, for the small tube does not affect the resistance of the notes, nor is the exterior of the piano altered.

(2) For teaching purposes the device has been of great use. The record on the roll of paper shows the faults so precisely that, although they are scarcely perceptible to the ear, there is no denying their existence.

(3) We are well aware that written music cannot show every slight change in the time the composer might desire. By applying the graphical method this difficulty is eliminated, and the time will be reproduced with the smallest details.—Nature.

AN AMPHIBIOUS BOAT.

THE means of communication for facilitating the carriage of passengers and freight are further and further developing. Denmark has long possessed steam ferryboats that carry entire trains across the Danish straits without its being necessary for the passengers to be shifted or the freight to be transferred. Not content with thus improving and facilitating carriage upon the sea, the Danes have likewise begun to cross the lacustrine isthmuses. The idea is evidently not absolutely new. Many years ago Capt. Eads proposed to carry the largest ships by rail across the isthmus of Tehuantepec in order to facilitate navigation between the Atlantic and Pacific. This grand idea remained in the state of a project merely, but the Danes have been able to put into practice a similar though more modest enterprise.

In the southern and most beautiful part of the island of Zealand there may have been seen in operation for the last three months an amphibious boat in which passengers cross lakes Lyngby, Fur and Farum, as well as the land that separates them. This new kind of boat was invented by Mr. C. J. Magnell, a Swedish engineer, and was constructed at the expense of a company, which, seeing its success, has decided to build some others like it.

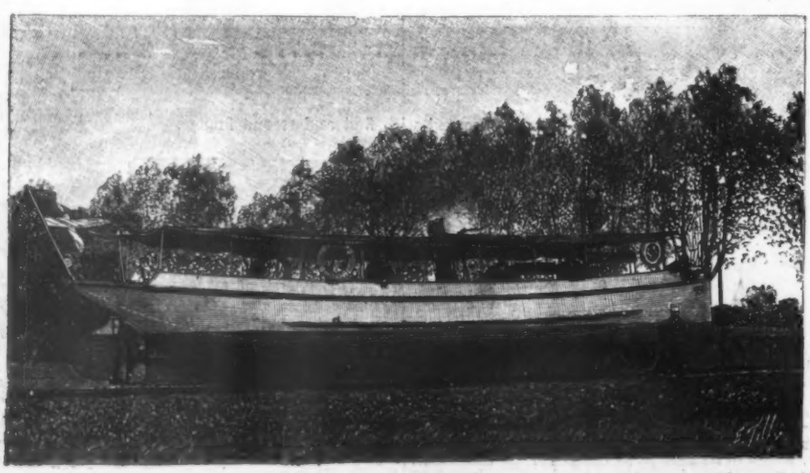
This amphibious boat, which bears the name of Svanen, that is to say, Swan, is 45 ft. in length by 10 in breadth (Fig. 1). Its engine is of 27 horse power. It carries 70 persons and cost 12,000 crowns, say about $3,400.

Near Fiskeboek, one of the most beautiful sites of Denmark, the isthmus that separates lakes Fur and Farum, 1,000 Danish feet (1,033 English feet) wide, is crossed by one of these boats. On each side of terra firma rows of piles form an artificial passageway, in the center of which there is a railway that runs down under water into the lake.

When the boat is to cross terra firma, which is intersected by a much traveled road, one bears upon a bar provided with teeth. These latter engage with the shaft of the screw, and immediately cause the revolution of four wheels placed in pairs fore and aft. These wheels, which are placed horizontally to the keel, afterward engage with the rails. The engine that actuates the screw likewise revolves the wheels and causes the boat to ascend and descend the slopes between the lakes upon gradients of one to forty.

The bottom of the boat, between the four wheels, is flat, so that the vessel rises but a few inches above the rails. The wheels are very wide (8 in.), and hollow like those of railway cars. They are inclosed in impermeable drums that prevent the water from entering the boat, but which become full when the steamer is navigating the lakes. In measure as the boat comes upon land, the screw is seen lightly striking the surface of the water at the stern, like the wings of a bird, and afterward beating the air (Fig. 2). This produces a singular effect upon those who observe the crossing of the isthmus by the boat. Finally, the boat descends on the other side and gradually enters the water, and the screw resumes its service, while, through a pressure upon the iron bar, the teeth are disengaged and the wheels resume an immovable position until the next landing. The experiments with the Svanen have naturally produced somewhat of a sensation among the inhabitants. Even the old sea dogs refused to believe in the possibility of the enterprise and considered it as an imaginary thing and of no utility; but, fortunately for the eminent and energetic men who stand at the head of this industrial undertaking, they were deceived. The Svanen crosses sea and land ten times a day during the week, and, on Sunday, runs uninterruptedly during the whole day. It has been decided to increase the number of these amphibious boats, in order to satisfy the exigencies of the public. We can only congratulate Mr. Magnell, the Swedish inventor, Captain Jensen, the manager of the company, and Engineer Velschow for having made a success of this very original and difficult enterprise, which will certainly find imitators in all countries.—La Nature.

THE AMPHIBIOUS BOAT CYGNUS LEAVING THE WATER.



THE CYGNUS PROPELLED OVERLAND BY ITS OWN MACHINERY.

THE FRACTURE OF GLASS WATER GAGES.

THIS subject is one of considerable importance, and Mr. Lavington E. Fletcher, chief engineer to the Manchester Steam Users' Association, has recently called attention to it in a notice issued to the subscribers of that association. The publication of his remarks may, perhaps, prove of service, not only in the interest of boiler owners, but also in the interest of the boiler attendants, who too often suffer personally by those fractures. Mr. Fletcher writes as follows:

FIG. 1.

FIG. 2.

FIG. 3.

THE FRACTURE OF GLASS WATER GAGES.

"The rise in boiler pressures, which has obtained in the last few years, while it has diminished the consumption of coal, has increased the danger arising from the fracture of glass water gages. One of the members of the Manchester Steam Users' Association, who has 26 boilers, each fitted with two glass water gages, writes in reply to inquiries, that during a period of 30 weeks his firm had to replace 128 broken glass tubes with new ones, so that a glass tube had to be renewed about every 1¾ days. Another of our members writes us: 'We are very much troubled by the breaking of the glass water gages of one of our boilers working at a pressure of 180 lb. on the inch, as many as 40 glasses having broken during the past nine months; about one every week, on an average. We have tried glasses from four different makers, and the result is always the same. As a rule, the whole glass is shivered to powder, but when any large pieces escape we find that the top part of the glass is usually very thin, and looks as if the high pressure steam had dissolved the glass away. The rest of the glass is in the same condition as when new.'

"In many cases the glasses fly when the attendant is testing the gage, and blowing through; in others they fly when not being tested or in any way disturbed. As the attendant when testing the gage is looking at the glass, it has sometimes unfortunately happened that he has been shot in the eye, and the sight destroyed. In one case, at Runcorn, on Monday, October 24, 1892, the cleaner of a locomotive engine was so severely scalded by the fracture of a glass water gage that he died two or three days after.

"Having regard to the high pressures of steam now in vogue, the fracture of glass water gages has become a question of serious importance, and is evidently worthy of attention.

"These fractures are due to a variety of causes, some of which may be enumerated as follows:

"1. To the brass mountings not being fixed correctly in line, and the glands of the stuffing boxes not working truly.

"2. To the brass mountings not being firmly held in position, as when connected to the boiler by pipes, so that movement occurs.

"3. To the brass mountings, when fixed to the front end of Lancashire boilers, being thrown out of correct line by the breathing of the front end plate. This breathing is aggravated by severe firing and sedimentary feed water, as they increase the bogging of the furnace tubes.

"4. To the water in the glass tube cooling down, so that when the gage is tested the sudden admission of the hot water from the boiler cracks the glass in the same way that a tumbler is cracked by pouring in hot water, in consequence of the inner surface being expanded more than the outer. This cooling of the water takes place when the gage is fixed some distance from the boiler and connected thereto by pipes, and also when the gages are exposed to a draught of cold air.

"5. To the wasting away of the top of the glass tube from the scouring action of the steam in blowing through.

"To protect the firemen from the danger attending the bursting of glass water gages, guards have been introduced. Some of these consist of two plates of glass ½ in. thick, arranged so as to form two sides of a triangle. (See Fig 2.) Others consist of one plate of glass ¾ in. thick, and two plates of metal, arranged so as to form three sides of a square.* (See Fig. 1.) Some of the earlier guards were found to fail when the glass water gage burst, several pieces of the guard being violently thrown to a distance, in one case right across the firing space and through an opposite window. To meet this, therefore, toughened glass is now used, and tested by dropping a hard wood ball upon it.

"To prevent these fractures and also to reduce the mischievous effect in the event of their occurrence, the following precautions are recommended:

"First, that the brass mountings be fixed correctly in line in the first instance, and that it be seen that the glands work truly.

"Secondly, that the brass mountings be securely fixed so as not to move and thereby strain the glass tube.

"Thirdly, that the tubes be procured from such makers as can be relied on only to use first class material, and to carefully anneal the tubes when made.

"Fourthly, that the tubes be not scratched by a wire or other instrument when they are being cleaned out, as insignificant scratches often develop into important fractures.

"Fifthly, that an efficient guard be adopted. The construction of these guards is receiving attention, and will no doubt be improved from time to time.

"Sixthly, it may be added that a vulcanized, coni-

* Since Fig. 1 was in print an alteration has been made in the design. The metal sides have been extended to the front of the glass plate, and made to clip it, the object being to enable it the better to resist a blow from the glass tube should it burst.

cal, flanged ring, on the principal of a Bramah's hydraulic cup leather, has been brought out for packing the ends of the tubes, in preference to the ring or series of rings usually adopted. The construction of this conical flanged ring will be best understood by reference to the accompanying sketch, by which it will be seen that tightening up the gland does not increase the pressure on the tube, but simply puts pressure on the flange. By this arrangement elasticity is afforded, so that in case there should be any slight movement of the brass fittings, the glass tube will not be strained (See Fig. 3.)

"The Manchester Steam Users' Association has not had sufficient experience of these conical packing rings at high pressure to speak positively of their success, but they promise so well that they appear to be worth a trial. It may be mentioned that in one case, in which they had not given satisfaction, the material of which the rings were made was inferior.

"The fracture of glass water gages has for some time been receiving the careful attention of the chief engineer and his staff. Inquiries have been set on foot to ascertain the circumstances under which fractures of glass tubes mostly occur, and if the members generally would send in the result of their own experience as regards the behavior of their glass water gages, it would be of assistance."—Engineering.

CONTENTS OF BINS.

To compute the contents in bushels of the bins or boxes used in mills and grain warehouses, multiply the length, in feet, by the breadth and this by the depth. Four-fifths of this product, according to the rules given by the Chicago Milling, will give the contents in bushels. If measurements are taken in inches, multiply as above, and divide the product by 2,150. To compute the contents of a hopper in bushels, multiply the length by the breadth, in inches, and this product by one-third the depth, measuring to the point. Divide that product by 2,150. To find the contents of a round tank, multiply the diameter by itself and the product by the height—all in feet. Multiply this by 0 63. The result will be in bushels. To determine the contents of a circular hopper, determine the diameter at top and the depth of the hopper to the joint. Then make calculations as though estimating the contents of a round tank having same diameter and depth. One-third of this amount will equal contents of hopper in bushels.

THE CENTENARY OF THE FRENCH INSTITUTE.

THE Institute of France, the centenary of which was celebrated October 25, 1895, had noble beginnings, which are confused with the history of the country. Its sires have honored France, and none of them died without surrounding himself with some luster, and without having left behind him at least one work useful to mankind. The majority of them were illustrious.

As far back as the sixteenth century, men occupied with the highest literary or scientific questions were thinking of uniting their forces for the good of the French nation. Their reunions, purely private at that time, left, it is true, no other memorials than the works produced by their members, but such works have, in a large measure, aided the progress of the human mind.

A century later the academies were created:

The French Academy received its letters patent in January, 1635. Cardinal Richelieu signed its act of regulation on the 22d of February following.

The Academy of Painting and Sculpture was founded by a decree of Queen Regent Anne of Austria on the 20th of January, 1648.

The Academy of Inscriptions and Medals was instituted in 1663, and was composed solely of four members, taken from the French Academy. Louis XIV prescribed orders for its management in 1701, and confirmed its establishment by letters patent in 1713. This academy assumed the name of Academy of Inscriptions and Belles Lettres that it bears today by a decree of the Council of State in 1716, under Louis XV.

The Academy of Sciences sat in the Colbert Library and then in the King's Library, from December 22, 1666, when Louis XIV granted it its first regulations of January 26, 1699. The Academy of Architecture, the creation of which was the work of Colbert, and the members of which were selected by Louis XIV, held its inauguration session December 31, 1671.

FIRST COURT OF THE INSTITUTE OF FRANCE.

DUC D'AUMALE,

Member of the French Academy, of the Academy of Fine Arts, of the Academy of Moral and Political Sciences, and Donor of the Estate and Collections of Chantilly to the Institute of France.

These are the five societies destined to reappear later on, that got their deathblow from the promulgation of the law of August 8, 1793, the text of which is as follows:

"Article 1. All academies and literary societies patented and endowed by the nation are suppressed.

"Article 2. Botanical and other gardens, cabinets, museums, libraries, and other monuments of sciences and arts attached to academies and societies are placed under the surveillance of the constituted authorities until some disposal thereof has been made by decrees upon the organization of public instruction."

The ruin of the academies was consummated on the 6 thermidor, year ii (July 24, 1794) by the adoption of a decree presented to the national convention by Ramel.

It was now 1795, the revolution had done its work, the tempest had carried everything with it, and the reign of terror also had disappeared. It was now a question with those who survived to rebuild upon new ground. It was now that the national convention prepared a constitution for France and put eleven of its members in charge of this formidable mission.

None of these legislators had had any connection with the fallen government, and none had belonged to the expired academies. The liberty of each was supreme, but the past was fraught with valuable instruction for them. The commissioners pursued their task amid innumerable difficulties, and, this once finished, they obtained from the convention a vote for the constitution long elaborated by them. The constitutional law, promulgated on the 22d of August, 1795, includes in title x, an article, 298, thus conceived:

"There is for the entire republic one national institute, whose mission it is to take account of discoveries and improve the sciences and arts."

The academies were to revive, modified without doubt, but united with each other and sure of the future.

Daunou was the soul of the commission, and it is to him that is due the honor of this creation. The principle having been admitted and proclaimed in the constitution, the commission did not content itself with this, but confided to Daunou, whose influence had become considerable, the preparation and the final terms of the law upon the organization of public instruction (October 25, 1795), title iv of which was to become the first charter of the Institute.

In the drawing up of this law, Daunou took inspiration from the ideas of Talleyrand and Condorcet, and also recalled Colbert's fine project, which consisted in establishing a close bond between scientists, men of letters, and artists, and, with their aid, forming a single body in which should be united all the live forces of the nation.

Louis XIV also had thought of this when he introduced into article xlviii of the regulations of 1701 the following arrangement:

"There will always be a particular union between the Royal Academy of Sciences and that of Inscriptions and Medals, and the first sessions of each, after the public assemblages, will be held in unison, in order that it may be learned from the secretaries what will be done in each."

This is of slight consequence, however, and Daunou remains none the less the creator of the Institute and the author of the law of October 25, 1795.

COSTUME OF AN ACADEMICIAN IN 1840.

COSTUME OF AN ACADEMICIAN IN 1895.

By the three first articles of this law the National Institute of Science and Arts is founded, and is to consist of 144 members residing in Paris and 144 distributed throughout different parts of the republic. It is to associate with itself foreign scientists to the number of 24, eight for each of the three classes that compose it.

The first class, that of physical and mathematical sciences, has 60 members, divided into 10 sections and 6 members—those of mathematics, mechanic arts, as-

HALL FOR EXTRAORDINARY SESSIONS.

tronomy, experimental physics, chemistry, natural history, mineralogy, botany and general physics, anatomy and zoology, medicine and surgery, rural economy and veterinary art.

The second class, that of moral and political sciences, has 36 members, divided into 6 sections of 6 members—those of analysis of the sensations and ideas, morals, social science and legislation, political economy, history and geography.

The third class, that of literature and the fine arts, has 48 members, divided into 8 sections of 6 members—those of grammar, ancient languages, poetry, antiquities and monuments, painting, sculpture, architecture, music, and declamation.

The national associates are distributed in like number through the sections of each of the classes.

As regards the formation of the Institute, article 9 prescribes that the executive directory shall name 48 members, who shall elect the 96 others. The 144 members united shall name their associates. After the Institute shall have been regularly constituted, it will have, inclusive of its foreign associates, 312 members. Here Daunou disappears, and to Lakavel is confided the preparation of the list of the 48 electors. These members, appointed November 20, 1795, came together December 6, and, in eight sessions, proceeded to the nomination of their 96 fellow members. On the 15th of December, the election being finished, the Institute occupied itself with projects of regulation and address.

On January 21, 1796, the council of the five hundred received at its bar the deputation from the Institute, which brought to it its regulations. Lacepede was the orator of the occasion.

"We come," said he, "in the name of the National Institute, to present to you the regulations which, by the terms of the law, are to direct its proceedings. Lovers of liberty, we have sought to cast aside all the servile forms of monarchical institutions. Avowed partisans of the republic, we owe it an eternal gratitude, since, in leaving to letters their entire liberty and all their luster, it re-establishes between the different families of sciences and arts that kindly fraternity that binds together all classes of society.

"We swear fidelity to this eternal alliance, contracted between science and liberty. Liberty will cause science to flourish, and the latter will give a new luster to liberty.

"The members of the National Institute have instructed us to make to you in their name the vow that they are at this moment making in the midst of their fellow-citizens; we swear hatred to royalty."

Treilhard presided over the council, responded to the address, and, upon the proposition of Chenier, embraced the members of the deputation.

The Institute was now organized upon a strong basis. Its three classes were to publish their labors every year. The entire society was to hold four public sessions annually, to render an account of the progress of the sciences to the legislative body, to publish a programme of the prizes that it proposed, and to judge of the competitions to which they should give rise. It was also to appoint every year twenty citizens, who were to travel three years at the expense of the republic and make observations relative to agriculture in the departments and in foreign lands. It had power, besides, to select six of its members, who were to travel in company or separately and make researches upon the various branches of human knowledge other than agriculture.

The ordinary sessions of the classes were to be held at the Louvre, in the halls of the old Academy of Sciences. The public sessions of the three classes united were to be held at the Louvre also, but in the Hall of the Caryatides.

Of these public sessions, the first was held April 4, 1796, and at this the Directory was present.

One important point remained to be determined, and that was relative to the amount to be paid to each of the members. This was fixed by the law of July 17, 1796, at 1,500 francs, subject to no reduction or stoppage. This figure is the same as it is to-day. Out of this sum a deduction of 300 francs was made, as to-day again, to form the fund to be distributed among the members actually present at the sessions. In the year iv, the number of the titular members being 144, this deduction furnished a sum of 43,200 francs to be distributed annually. At present, the number being 229, the sum to be distributed is 68,700 francs. In 1796 each of the members, then, received 1,200 francs, to which was added his part of the "droit de presence." The same is the case in our day.

For two years the sessions occurred amid the greatest calmness, up to the moment in which the Directory, accomplishing the coup d'etat of the year v, proscribed (September 5 and 8, 1797) five members of the Institute: Barthelemy, Pastoret, Sicard, De Fontanes and Carnot. The names of the first three candidates proposed by the section of Mechanical Arts were those of Bonaparte, J. V. M. de Lacroix Dillon and the Marquis de Montalambert.

Bonaparte was elected at once. This occurred December 25, 1797. The very next day he sent a letter of thanks and went to take his place in the first class.

His election was to exert a great influence upon the destiny of the Institute. At his very entrance, moreover, he was treated in a peculiar manner. Andrieux, having sent him a dedicatory epistle accompanying some pieces of music signed by Reicha, ended his letter as follows: "I salute the hero whom I have the honor to have as a colleague."

Upon his return from Egypt, Bonaparte resumed his place among his confreres October 23, 1799, and, four days later, the Institute offered him a medal engraved by Duvivier and struck in platinum. The official letter accompanying this medal began as follows: "The medal, citizen fellow-brother, that the National Institute commissions us to send to you must, by the nature of the metal of which it is formed, last almost as long as your glory."

The Institute then foresaw the possibility of introducing some modifications into its organization, and was looking for a protector, which it hoped to find in Bonaparte. On November 9, 1799, the Directory was overthrown and Bonaparte had himself proclaimed consul. On the 22d of March following, the first class made him the president of its assemblies.

Bonaparte recognized the great honor of his title as member of the Institute and gladly sought occasions to prove his sympathy to his confreres. Wishing that they might take a place more officially in the great state bodies, he gave them a costume by a consular decree of May 13, 1801:

Article I.—For the members of the National Institute there will be a full dress and undress suit.

Article II.—The costumes are regulated as follows; Full dress.—Dress coat, waistcoat, black breeches or pantaloons embroidered with an olive branch in dark green silk. Undress suit.—Same form and color, but having no embroidery except at the collar, and at the facing of the sleeve, with a ruffle upon the edge of the coat.

The Institute, on its side, deeply attached to Bonaparte, showed itself respectful as well as grateful. On March 26, 1802 on the occasion of the peace signed at Amiens, the Institute was received by the first consul, and its president delivered a speech full of admiration and adulation. On June 15, 1802, Bonaparte responded to these marks of attachment and admiration by the creation of the prize for researches in galvanism, thus affirming once more the interest that he took in the renown of the Institute, upon which he had his eyes constantly fixed. Such interest was still more strikingly shown by the law of January 3, 1803, prepared by Chaptal and signed by the first consul at the palace of St. Cloud. This law reorganized the Institute in four classes: (1) that of Physical and Mathematical Sciences; (2) that of the French Language and Literature; (3) that of Ancient History and Literature; (4) that of Fine Arts.

This was a tendency toward a return to the academies. Moreover, Article 8 of the law emphasized such tendency: "The nominations for vacant seats will be made by each of the classes in which such seats happen to become vacated. The subjects elected will be confirmed by the first consul."

The first class (the Academy of Sciences) was divided into ten sections of six members; those of geometry, mechanics, astronomy, general physics, chemistry, mineralogy, botany, rural economy and veterinary art, anatomy and geology, medicine and surgery, and a new section of three members: that of geography and navigation. It had eight foreign associates and a hundred corresponding members.

The second class (the French Academy) was composed of forty members. It had in charge the making of the French dictionary, and the examination, from the view point of linguistics, of the important works of literature, history and science.

The third class (the Academy of Inscriptions and Belles Lettres) was composed of forty members, eight foreign associates and sixty correspondents. Its object was the study of the learned languages, of antiquities and monuments and of all the moral and political sciences related to history. It was also to enrich French literature with Greek, Latin, and Oriental works, and to occupy itself with the continuation of diplomatic collections.

The fourth class (the Academies of Painting, Sculpture and Architecture) was comprised of twenty-eight members divided into sections; of painting (ten members), of sculpture (six members), of architecture (six members), of engraving (three members), of musical composition (three members). It had eight foreign associates and thirty-six correspondents.

In possession of this law, which gave it all the satisfaction desirable, the Institute immediately prepared its internal regulations and had them approved by the first consul May 9, 1803.

By a decree of March 20, 1805, Napoleon, who was now emperor, wishing to introduce important improvements into the palace of the Louvre, gave the palace of the Four Nations to the Institute for its sessions. He commissioned it also to decree the decennial prizes that he had just founded, and created a competition upon croup.

A little later on, the emperor requested the Institute to form a general record of the state and of the progress of science, literature and art from 1789 up to the 1 vendemiaire, year x, and decided that such a record should be presented every five years. The Institute set itself at the work and presented its first report February 6, 1808.

Napoleon was now at the height of his power, but as he had no direct heir and was thinking of the future, he severed the bonds that connected him with Josephine and married Marie Louise, April 2, 1810. On this occasion the Institute held an extraordinary session and decided to illuminate the palace of the Four Nations.

Unfortunately, the campaign of 1812 and then that of 1813 was to begin.

In the wake of the latter, the emperor, desiring to consecrate the memory of the victory obtained over the Prussians and Russians at Wertschen, signed two decrees devoting twenty-five millions to the erection of a monument upon Mont Cenis, opposite Paris. This project collapsed amid the general conflagration at the end of 1813, and events precipitating themselves, the senate, on April 3, 1814, proclaimed the emperor's fall.

Two days later, on the eve of the very day upon which Louis XVIII was proclaimed king, the Institute united in general session, and one of the secretaries read a speech which ended in proposing to declare that the Institute of France adhered to the act of the senate that had pronounced the fall of Napoleon Bonaparte and the members of his family. This decision, adopted by the academic assembly, led the Institute to solicit the honor of being received by the Emperor of Russia. In response to this spontaneous invitation, the Emperor Alexander and the King of Prussia visited the Institute and there listened to an oration from its president. On the eve of this day Napoleon had said farewell to his guard at Fontainebleau, and on May 4 he took possession of the Isle of Elba, the seigniory of which had been conceded to him. His stay here was short, and on March 1, 1815, he sailed for France and reached Paris on the twentieth of the same month.

The Institute quickly forgot its preceding resolutions, and did not wish that any account should be taken of them. On March 28, united in general assembly, it drew up an address to the emperor in which it declared that, with all France, it had been calling for a liberator, and that Providence now had sent one!

Napoleon listened to the reading of this address on April 2. How he received these new assurances of devotion is not known.

He preserved the title of Protector of the Institute up to the end of the Hundred Days. With this title he figures in the annual of the organization for 1815.—La Nature.

[Continued from SUPPLEMENT, No. 1050, page 16782.]

THE ARC LIGHT.*

By Professor SILVANUS P. THOMPSON, D.Sc., F.R.S.

LECTURE III.

MECHANISM OF ARC LAMPS.

IN the six years that have elapsed since I had the honor of reading a paper on this subject before the Society of Arts, in March, 1889, a great deal has been done to develop the mechanism of arc lamps. On that occasion there was circulated among the audience a schedule of the various parts of the arc lamp, or rather of the various things for which mechanism has to be provided.

A few words of explanation are needed as to the meaning of some of the expressions used. By "kinematic train" is meant the particular mechanical device that holds the carbons from feeding until freed at the proper time. "Moderating" mechanism is instanced by the dash pots and the fan governors found in some lamps. "Replacement" refers to such arrangements as there may be for replacing the carbons when burned out, "change over" to the mechanism for bringing a second pair of carbons into play.

In nearly all modern lamps gravity is used as the driving power. The weight of the upper carbon in descending, or that of its rod or attachment, is in almost every case the motive power in the lamp for propelling the parts. The kind of mechanism or kinematic train that is employed seems to be gradually simplifying itself. In the former paper the typical varieties of mechanism in use were considered in detail. There was the rack and the train of wheels driven by it; there was a method of having a clutch or a clamp on a carbon rod; there was the method of employing a brake-wheel or a clutch-wheel, so common in English lamps; there was the method of feeding by means of a screw which could propel the carbons toward one another or separate them; there was the cord and pulley. Also there were certain other more special motions; for instance, one very beautiful one, using a small electric motor to drive the carbon. Then there were various ways of arranging the "feed" to take place by vibration or by some periodic action similar to the striking or chiming mechanism of the ordinary clock. There were attempts at making continuous feeds, so that the carbons should always be in motion, slowly approaching one another, all the regulation needed being effected by the lamp itself, which altered the speed to make it a little quicker or a little slower when necessary. Then there were some hammering feeds employing a method of propelling the carbon, or something that held the carbon, by definite blows through the clutch which held the carbons apart. All these mechanisms persist, but some are much more favored than others in the lamps that have been introduced since that time.

SOME EARLY ARC LAMPS.

It may be convenient here to introduce a picture or two relating to the mechanism of lamps in general. The first will be a very old one, an invention of W. E. Staite, a man whom the electrical profession has never recognized as he deserves to be; one of the pioneers on the whole subject of electric lighting, and inventor in 1846 of the first automatic mechanism for regulating the arc. Staite produced not one, but something like a dozen different forms of mechanism for lamps. In 1867 he had an arrangement equivalent in principle to some of those mechanical devices which have found favor of late. He fed the lamp from the bottom. The lower carbon was caused to be lifted up either by a weight going over a pulley with a cord fastened at the bottom or by a float. Fig. 21 shows

FIG. 21.

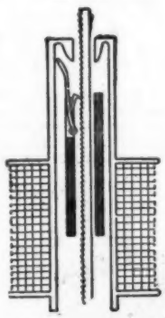
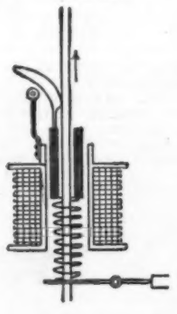


FIG. 22.



the rod for holding the lower carbon, with ratchet teeth cut in it. These teeth are caught by a pawl pivoted to the top of an iron tube which surrounds the rod, the whole being surrounded by a series coil, which, when actuated by the main current, sucks down the iron tube against the constant upward force. As the carbon burned away and the current diminished by reason of the arc lengthening the tube slowly rises, and, of course, with it the clamp with its carbon. Presently the extension of the pawl is pressed against the inclined plane at the top, releasing the clutch, and the lower carbon is moved upward. Another somewhat similar device which Staite had in 1852 is worthy of notice. In this case (Fig. 22) there was also a tubular core sucked down into a solenoid; the core being absolutely supported by a spring and a balance weight. The rod passing through it was clamped by a peculiar clutch, the tail of which caught against a little wheel. The current in the coil, when turned on, pulled this down, pressed the curved arm against the wheel, and, therefore, pressed one end against the rod, and drew the rod down a little bit, so striking the arc. When the current in the main circuit became weakened, the curved brake-piece rose

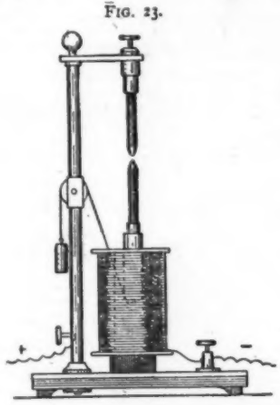
* Lectures delivered before the Society of Arts, London, 1895.—From the Journal of the Society.

and released the carbon, which was allowed to slip up a little bit and feed the arc. It is a complete foreshadowing, only upside down, of some clutches which have been used in quite recent years. Looking at this device of Staite's and remembering that he also had a most beautiful wheelwork lamp in 1846, with a differential gear to turn a screw-feed one way or the other, we see what a relatively crude thing it was that Foucault brought before the world * in 1849. In Foucault's lamp the carbons were horizontal, and were made to approach one another by running on two little trucks; the position of the trucks being governed by cords running over a pulley, one being set by hand and the other one, which moved toward it, being allowed to advance by a cord which was wound up on wheelwork geared to a double train of wheels inside a box. That box had to be wound up by a key like ordinary clockwork, and, having a differential train of wheels, was governed by an automatic arrangement of an electromagnet, with an equalizer on the armature and working against a spring. If the strength of the current were exactly right to balance that spring, an arm which went up vertically from the pivot stood in a perpendicular position. If the current were too strong, naturally the arm would be turned one way, and if the current were too weak the spring would bring it the other way. The position of this arm determined the question whether the train of wheels inside the box should turn to the right or to the left, whether, in fact, the carbon should be allowed to advance or retreat; or to move neither way, if the current was exactly right. Foucault added a beautiful variable resistance produced by two triangular and diverging pieces of metal dipping into water. As they were raised up near the surface, not only did they offer for conduction a diminished surface, but there was an increased distance between them. The whole contrivance constituted electrically an extremely beautiful arrangement, but mechanically was about as bad as could be conceived, the parts were so diffuse.

In developing this apparatus in later years, after the Serrin lamp had been introduced, Foucault was aided by the mechanical genius of Duboscq. In the well-known Foucault and Duboscq lamp of 1863† there was combined in good shape everything, except the variable resistance, that there was in the primitive arrangement: the carbons to be propelled toward one another, the differential train of wheels requiring to be wound up by a spring, and the lever which would let off one or other end of the train of wheels and allow the carbons either to approach or separate, according to whether the current was too weak or too strong.

If one returns to the historical development of this subject, the next lamp in order was devised by the architect Archereau, of Rouen, about 1848 or 1850. He had a solenoid with an iron core, acting against a little weight, as shown (Fig. 23). The weight would

FIG. 23.



bring the carbons together, and the solenoid would part them. A lamp like this "pumps" very much; it moves up and down, and there is a great flickering in and out when starting; but when you once get it set, it may feed very satisfactorily. This may be regarded as the forerunner of all the electric lamps; there is no clockwork; the action merely depends on the balance between gravity and the pull of the electromagnet.

Now let us go at once from these ancient things, which I have merely taken as typical of their kind, to lamps current in 1889. In the closing remarks of my lecture on that occasion I referred to two or three types of lamps as being characteristic of the respective countries, and the last sentence ran thus:

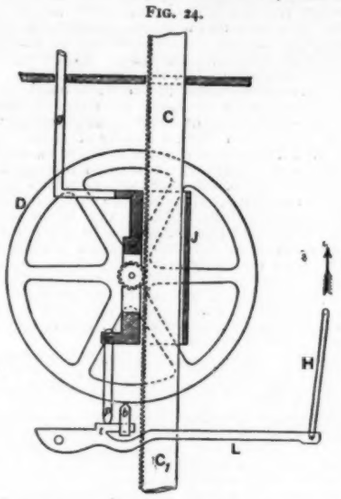
"In conclusion, it may be pointed out that there exists a curious sort of family likeness between the several members of the three species of lamps most in use. The rack-train lamps, which may be considered as the prevailing Continental type, are, for the most part, in their design and construction, clockmakers' lamps; they have a horological aspect. The clutch lamps, so universal in America, have a sort of sewing-machine look, the working parts being only finished where necessary for actual work, all else being left rough or merely painted over. The clutch-wheel lamps favored by British inventors have, in contrast to these, a look as though they had been designed and constructed by a trained engineer; they are essentially engineers' lamps."

That was justified by the comparison of the earlier rack and train clockwork lamps and the American type of clutch lamps, and two in particular of those which had been developed on British soil; and of those two lamps I reproduce the essential features here.

TWO MODERN BRITISH LAMPS.

The first lamp is the lamp which Mr. Crompton, in conjunction with Mr. Crabb, perfected about that time. The principle of its mechanism will be seen from Fig. 24. On the carbon rod is cut a rack which drives a brake wheel, or rather a pair of brake wheels one behind the other on the same pinion. The arbor bearing is not fixed in the frame of the lamp, but passes through a short sleeve or jockey, which, when the wheel is free to turn, can slide up or down the carbon rod, but is prevented from turning sideways by the guide pin, g, above. Below the brake wheels is a lever L, pivoted at o, and attached by a link, H, to the core

FIG. 24.



of the solenoid overhead. This lever carries a small table, t, and brake piece, b, faced with phosphor bronze. When the lamp is out of action the free end of the lever is down, and the weight of the wheels and the carbon holder bears down upon the table, t, by means of the pin, p, which projects from the jockey sleeve. In this position the wheels do not touch the brake piece, b, and are free to rotate, so that the carbon rod is free and the carbons are together. When the current is turned on, the main current coil attracts its core, first drawing up the lever, which, turning on its pivot as it rises, brings the brake piece against the rim of the brake wheels and prevents them from rotating. Any further rise of the lever lifts the brake wheel jockey and carbon holder, thus striking the arc. As the arc burns away and the shunt coil comes into action, the lever descends slowly, feeding the arc as required, and before it gets to the end of its tether the brake wheels are released and feeding takes place by the release of the carbon rod, the inertia of the wheels preventing any jerky motion.

Contrast that with the corresponding part of the well known Brockie-Pell lamp. That lamp was already at that time a famous lamp, and has more than justified its existence since. It had also a brake wheel, driven straight off the rack of the carbon rod; and the brake that played against this wheel was a small projection, with a bit of leather or India rubber round it, which was pressed in against the inner side of the rim of the wheel. There was loosely pivoted to the same center a large sector piece which, as a matter of fact, was weighted to make it heavy; and upon that sector piece there was pivoted an auxiliary lever, which was worked by a seesaw overhead, the seesaw itself being operated by two cores, which ascended into a solenoid. One core, in a main circuit solenoid, pulled up, and the other core, in a shunt solenoid, opposed it. Suppose the main current is very strong at the moment of striking the arc, this core is pulled violently up. The first thing that happens, then, is that the auxiliary lever is caught at its tail by a fixed piece, and turns round on its pivot, raising the weight and clamping the little brake piece against the interior part of the wheel, and then, if there is any further rise, they rise solidly together: that is to say, the auxiliary lever, the heavy sector, and the wheel all rise together about a center, and raise the carbon, and strike the arc; in fact, one has a kind of internal toggle brake against the rim of the brake wheel.

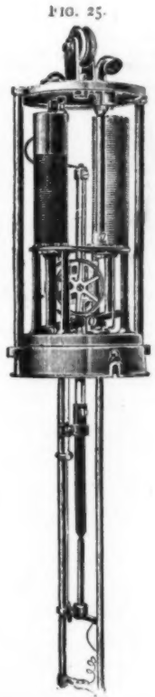
About this time Mr. Brockie modified his mechanism and put the little brake outside instead of inside, and he has made various detailed improvements since, and has brought out several patterns of lamps. Here is one of the forms of brake wheels now employed in one of the many lamps made by Messrs. Johnson & Phillips under Mr. Brockie's superintendence. In this case the upper and lower carbons are carried by flexible cords, which pass over two pulleys rigidly fastened together, but electrically insulated at the back of the wheel. The wheel in this case is put at the top of the mechanism of the lamp, instead of being at the bottom. The electrical action has to perform the following function. When it attempts to raise the long lever which is sprung across the middle, the little auxiliary lever causes the brake piece to bite against the inside: they are gripped together tight, and the whole thing has to go round together. When the long lever is let down, however, owing to the small auxiliary lever descending with its tail upon a fixed point, the grip is released, the wheel can turn, and the arc can feed little by little as the motion allows the wheel to turn. To strike the arc it has to turn a little backward; to feed, it must be allowed to creep forward as wanted by imperceptible degrees. A similar sort of arrangement of a clutch against the moving part Mr. Brockie has used in another pattern kind of lamp, which is favored by the post office, wherein there is no brake wheel; the clutch works in that case on a perpendicular rod.

I believe that all the inventors of arc lamps go through a species of evolution themselves. Take almost any one of the many names in arc lamp work—take Mr. Brockie as an example, or Mr. Crompton, or almost any other—and you will find that the inventor is never satisfied with his first performance. He is impelled to go on, and the record of almost any one of these men will show that they have tried successively various types, and have gone on, sometimes on one line, sometimes on another, developing and perfecting, until they got something very near perfection indeed. The brake that Mr. Brockie has in this lamp is, I suppose, about as near perfection for minute feeding as any brake applied to the rim of a wheel could possibly be. I alluded just now to one feature of the Brockie-Pell lamp—the use of the seesaw piece. This seesaw is a lever operated by two iron cores going up into solenoids, one of which is included in the main circuit, while the other is joined as a shunt. It was no new thing in 1889 to have a differential motion in a lamp. The first one was about 1855. The well known Brush arc lamp had differential winding on the electro-magnet, the series and shunt coils working against one another. Even earlier than that Siemens had a differential solenoid working at the two ends of a straight core; the series coil trying to pull the core down, the shunt coil trying to pull the core up; but so far as I am aware the special advantage of this seesaw arrangement with a shunt at one end and a series at the other was in 1889 not generally recognized.

True it existed in the Thomson-Houston lamp, and in the Brockie-Pell, but scarcely in any other lamps. Now the real advantage of using a seesaw over a differential winding or over a differential plunger is this: that in this case when both the opposing parts are fully in action, when the main circuit coil only is pulling hard at a, the shunt coil is pulling hard at b, the lever is subjected to considerable forces, nearly balancing one another, and any small difference arising from any change of the current in either coil would be quite sufficient to produce the required movement action. Even if there were friction in the parts the movement will occur with certainty, because the forces balancing one another are comparatively large mechanical forces. Whereas in the American plan of using a differential winding, when the two coils have their magnetizing effect nearly in balance, the magnetism is almost zero, and, therefore, the forces are almost zero; and hence the mechanical effect is comparatively at a disadvantage in contending with any tendency of the mechanism to stick. Friction plays a much more important part in determining whether the feeding apparatus is or is not to act in those lamps where you do not utilize to the full the mechanical value of both the currents, that in the main circuit coil and that in the shunt coil. Here in the seesaw, they are utilized to the full. It is quite remarkable how the seesaw mechanism has, since 1889, grown into favor with other inventors. Kent's lamp, for instance, has a seesaw. At one end there is a shunt electromagnet, and at the other a series electromagnet. The seesaw is between the two, so that the mechanical pull of both coils is utilized to the greatest extent.

In Fig. 25 we have the Crompton-Pochin lamp—of which the brake wheel part is practically identical

FIG. 25.



with the Crompton-Crabb brake wheel (Fig. 24), but instead of having a long solenoid, with an iron core, to be pulled by a lever, there is a series coil and a shunt coil at the top of the lever working the seesaw. One might point to other lamps of modern type, in which the same seesaw arrangement has survived the less effective forms. In the latest Crompton-Pochin lamp the seesaw operates a band brake. The lamp hanging before you is the form of lamp now produced by the Brush Company, under the name of the Brush-Vienna lamp. I believe the greater part of its mechanism is due to Mr. Kremenetsky, of Vienna. It has a series coil, and a shunt coil, and a seesaw working between them. As in many other Continental lamps in which clockwork or wheelwork is still employed, the operation of the electromagnets of the lamp is to rock over the clockwork bodily, both for striking the arc and for determining whether the feed shall occur or not. You will find that in a very large number of lamps that have developed of late years the question whether the train of mechanism shall or shall not be permitted to turn is made to depend on the position of the wheelwork as a whole, and the wheelwork is turned round on some convenient axis. One's mind travels back to 1882, at the time of the Crystal Palace

* See Foucault's own article on "Electric Lighting" in the "Dictionnaire des Arts et Manufactures," 1852. It is reprinted at p. 317 of the "Recueil de Travaux Scientifiques de Leon Foucault," edited by M. Gariel (Paris, 1878).

† See "Travaux Scientifiques de L. Foucault," p. 322.

Exhibition, when there was a lamp with tilting clockwork in it, shown by Mr. Brockie; a lamp which was never extensively employed, because Mr. Brockie went on to higher things.

(To be continued.)

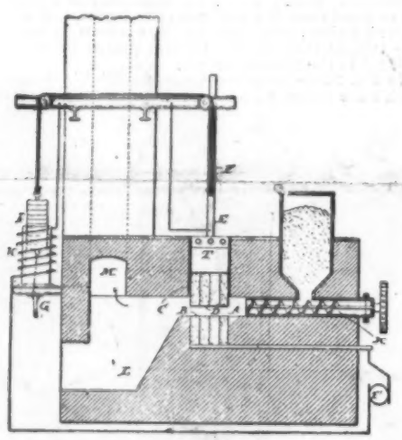
CONTINUOUS ELECTRIC SMELTING FURNACE.

ELECTRIC smelting processes as now generally carried on are discontinuous in their nature; that is to say, the furnace is charged with a given amount of mineral to be reduced or converted, and when the process is complete the furnace is emptied and a new charge inserted. This method of working usually puts the furnace out of actual operation for some time, so far as actual smelting is concerned, and to that extent entails a loss of time. To effect a desired economy in this respect, Mr. J. A. Vincent, of Philadelphia, Pa., has designed an electric furnace in which all the operations are continuous, which is illustrated in the last number of the (United States) Electrical Engineer.

The manner of operation of the Vincent furnace will be readily understood by an inspection of the accompanying engraving, which shows it in section. Here A is a horizontal channel-way having a bed, B, of carbon, which is stationary, and acts as one of the electrodes.

C is a vertical opening extending into the channelway, and in this is arranged the other electrode, D, consisting of rectangular carbon blocks held in a metal clamp, T, which is raised and lowered by a rod, E, ropes and windlass, G. As the carbon, D, is consumed the electrode is bodily lowered, so as to approximately keep the two electrodes at the same or uniform distance apart to maintain an arc consuming substantially a constant current and voltage.

As it is more desirable to make the feeding of the movable or positive electrode automatic, this is accomplished by providing a solenoid, H, in series with the electrodes in which a magnetic core, I, moves. This core is connected to the ropes, F, and by them raises or lowers the electrode, D, in accordance with the requirements. When this electrode regulator is used, the connection with the windlass, G, is only in setting the electrode in position. It is desirable that the clamp, T, substantially close the vertical opening, Co,



so that little or no air can enter to abnormally consume the carbon of the electrodes.

The ore or material to be treated is finely pulverized and placed in a hopper, J, from which it is received by the feeding screw, K, which forces it into the channelway between the electrodes. As the smelted product is formed, the incoming unsmelted material forces it into the pit, L, where it is collected and kept in a hot atmosphere until ready to be removed.

The stack, M, is provided for the escape of gases generated by the smelting operation, and opens laterally from the channelway at its discharge end, it being desirable to have the channelway continuous and uniform in cross section throughout its length, especially where it receives the electrodes, B and D.

The furnace is specially adapted to the production of calcium carbide.

ELECTRICALLY DRIVEN OCEAN STEAMERS.

BY those conversant with the problem attending the propulsion of large steam vessels, it will be conceded that the limits of practical speed have with the present apparatus been pretty well reached. At the present time most of our large passenger vessels work certainly at uneconomically high rates, and probably at speeds on which but little improvement is, from an engineering standpoint, possible. The difficulty with the bearings in high seas, when the propellers are apt to race, is not a trifling matter, but in addition to this consideration, speeds have a very detrimental effect upon the structure of the ship, involving either unnecessarily heavy construction or shaking of the vessel to pieces. An American inventor, who advocates the use of electricity for propulsion of ocean going steamers, is about to equip a steamboat on the following lines: He will put in his boat a powerful engine of the slow speed type, connected to a multipolar generator transmitting current to electric motors attached directly to the propeller shafts. The motion of the motors being rotary, a very high speed could be attained with comparatively little vibration, while the reciprocating part of the propelling machine—the engine—could be run at a comparatively slow speed. The further advantage of better regulation in rough weather, when the propellers lift, would be secured.—Electrical Plant.

TEA CHESTS OF TINPLATE.

TINPLATE manufacturers abroad have been casting about for new markets for their product, and a considerable demand has been created for plates for the manufacture of tea chests. A company in Glasgow is doing a large trade in metal tea chests, which are sent out to India at a cost of 84 cents each. Two years ago when this company commenced the manufacture of these chests, the orders amounted to 1,750,000 pounds; in 1894 this amount had increased to 10,000,000 pounds, and orders for 30,000,000 pounds were counted upon for 1895. The principal obstacle encountered, says the Philadelphia Record, is the difficulty of getting tea merchants to adopt the new idea. In the opinion of the largest dealers in tea, the chief objection has its root in the inadaptability of the metal chest. It cannot be manipulated so easily as if it were made of wood. The difficulty, however, might easily be overcome by having on hand a supply of chests varying in size. A further disadvantage arises in cases of leakage. When a wooden chest sustains damage a piece of timber can be nailed over the hole which has been made and the leakage stopped, but with a metal chest "nothing can be done." But really, a piece of scrap tin, some solder, a little muriatic acid, a hot soldering iron and a tinker might greatly assist. Against these disadvantages it is only fair to say that a number of tea dealers are quite favorable to the tinplate tea chests as means of packing, and there is very little doubt that the tinplate trade on both sides of the Atlantic has an enormous future before it in this connection.—Boston Journal of Commerce.

THE PNEUMATIC LADDER.

IN every order of things, especially in point of the organization of material of war, the ancients are our masters, or more exactly, our initiators. If we examine their didactic treatises, we shall be much surprised to learn that they were well acquainted with what we believe that we invented. Further, they pursued methods of which the tradition has been lost, and did offhand what we are now unable to do. If it were a question, for example, of proceeding to the attack of a fortified enceinte by forcible means, they attempted the scaling of it through the use of pneumatic ladders, a description of which is found in Philo's "Attack of Plaus," and the "Poliorcetics" of Heron of Byzantium.

These ladders, which were made of leather, were sewed like water bottles, or, better, like fire hose.

In order to render them impermeable, they were

THE PNEUMATIC LADDER.

covered with grease throughout the entire length of their seams.

Thus organized, these apparatus, uprights and rounds, were filled with air until they were properly inflated. How did the ancients manage to effect this operation of inflation? They evidently made use of bellows. What is certain is that these leather ladders did not allow the air with which they were filled to escape. Now, this air, compressed to a certain extent, gave the uprights, as well as the rounds, a notable solidity. The ladders necessarily became rigid and allowed the assailant to attempt an escalade.

Could the method of construction of the pneumatic ladder of the Greeks have inspired the inventor of the pneumatic tire? One would be tempted to believe so. However this may be, the moderns, having rubber and powerful blowing apparatus at their disposal, ought to imitate the ancients, and consequently discard the use of wooden ladders, which are so cumbersome and difficult of carriage.

Above the pneumatic ladder represented in our figure, taken from a Byzantine manuscript, is seen an apus reticulatum, an explanation of which it remains for us to give. It is a complementary method of scaling. "If," says Heron of Byzantium, "the wall whose battlements are to be reached is higher than the leather ladders placed against it, recourse will be had to the use of reticulated ladders. These are formed of a canvas of cords sewed in such a way as to resemble a net or reticule analogous to that called a sarkina. The upper part of this net should be provided with hooks in order that it may fasten itself to the wall when it is thrown to the top of it, and thus render the ascent of the assailants easy."—La Nature.

BAD BEVERAGE IN GOOD BOTTLES.

IN England and most European countries fraudulent imitations and forgeries are held in check by the fear of detection by the agents of manufacturers, who make false trade marks their special study. A new assault on patent rights has been discovered in Egypt. There is immense consumption of English drinks by the well-to-do travelers who pass through or those who reside in Egypt. The empty bottles are collected, and the labels and capsules are imported from France, Germany, and other countries, and pasted upon the bottles of Guinness, Bass, or Schweppe. The firms thus affected have appointed an expert lawyer of Alexandria to protect their interests as far as possible. This agent in examining the books of only one maker discovered that 61,650 bottles of soi-disant Bass' beer had been sold in three and a half years. The contents of the bottles were generally of a most noxious nature.—Leisure Hour.

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